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NOTES ON BIRDS OF SINALOA AND NAYARIT, MEXICO, IN THE FALL OF 1925

BY

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The specimens forming the basis of this report were secured by the writer in Sinaloa and Nayarit (= Tepic), Mexico, during the months of September and October, 1925. Field work was carried on at three collecting stations, and the time was so apportioned that September 18 to 28, inclusive, was spent at Labrados, Sinaloa; October 2 to 19, inclusive, and October 29, about San Blas, Nayarit; and October 21 to 26, inclusive, on Maria Madre, Tres Marias Islands.

Both Labrados and San Blas are situated in the southern extension of the alluvial plain that stretches along the northwestern coast of Mexico between the Sierra Madre Occidental and the sea. At many points this plain is cut transversely by the rivers which formed it, and, at its seaward margin, river silt and sea sand have united to form long, narrow islands, behind which the waters of the rivers find their tortuous way to the ocean. A veritable maze of decussate waterways,—fresh, brackish, and salt,—in extent dependent upon season and tide, form about the river mouths, and the inter-relationships of the various "esteros" are almost impossible to determine.

In the vicinity of Labrados, spurs of the Sierra Madre Occidental encroach upon the coastal plain so that but a six-mile
strip of level land lies between them and the broad estero cutting Palmito de la Virgen from the mainland. At San Blas, volcanic masses, attaining no great elevation, come down to the sea; and off shore, other such masses form small, rocky islets.

The Mexican “tierra caliente”, within which the three collecting stations lie, has but two seasons each year,—one wet, the other dry. These seasons vary in time and duration, but in the regions under consideration, the dry season extends, roughly, from about the first of October until the end of June, occasionally the drought being broken during the early spring months. The months of July, August, and September are rainy, but the wet season is sometimes unusually prolonged, as in the case of the year 1925, when rains were still falling

![Fig. 1. The Labrados region.](image-url)
on November 9. The heavy precipitation at this period fills arroyos, inundates woods, turns fields into impassible swamps, and transforms roads into freely flowing streams.

Labrados (or Labradas, both spellings being in vogue), some 25 miles southeast of Mazatlan, is in the Arid Tropical Region, for the rainfall, although heavy during the wet season, is but about 30 inches a year. Low temperatures prevail at night during the winter months, and killing frosts occur as far south as the Santiago River. These climatic conditions are reflected in the vegetation. There is a strongly xerophytic aspect about the flora of the region. The growth as a whole

Fig. 2. San Blas and vicinity.
is low, and thorny shrubs, such as mimosas, acacias, etc., and cacti preponderate. As the name indicates, most of the land in the environs of the railway station of Labrados, is, or has been, under cultivation, and the thickets are interrupted by stretches of fallow land, overgrown by a tangle of weeds and vines, or, less commonly, by fields of corn.

The marches of the Humid Tropical Region include the area about San Blas. Although temperatures low enough to retard the ripening of bananas obtain in the winter months, San Blas is out of the zone of frosts, and an annual rainfall of nearly 60 inches induces a luxuriant growth of vegetation. A dense jungle clothes the hills to the east of the town, and Camaron and Blanca de Tierra points. Several palms are indigenous to the region. Pipers are in evidence in the low growth. Red-spathed bromeliads grow in the interstices of rocks and in the crotches of trees, waxy bignonias flourish in

Fig. 3. Maria Madre Island.
the deep shade, climbing aroids entwine tree trunks, and many unknown *bejucos* form a network in the low growth. Esteros, margined by mangrove swamps, line the face of the country in all directions, and leave but a small extent of grass- and weed-grown fields in the vicinity of the town.

Maria Madre Island, lying some 80 miles to the seaward of San Blas, is the largest of the Tres Marias group. It is about 15 miles long and eight wide, and the rocky ridge which forms the backbone of the island attains an elevation of 2020 feet in the central portion. The southern and eastern faces of the island are covered with what appears to be a second growth scrub, and the vegetation testifies to a prevailing aridity. The timber clothing the ridge and the western slope grows with greater luxuriance, and a wealth of ferns, orchids, and bignonia gives evidence of moisture deposited by the winds from the Pacific.

As the northwestern coast of Mexico has been a field of operations for ornithological collectors since the days of the *Blossom*, it was not expected, aside from filling some blanks in the museum’s series and adding specimens of northern birds in winter plumage, that the collections secured would be of great interest. The work of Xantus, Forrer, Grayson, Bischoff, Nelson, Goldman, Simons, Batty, and others, in some cases carried on over a period of several years, might have been expected to have cleared the slate of novelties and left but few facts of distribution to be revealed. It was, therefore, with considerable surprise that a specimen of a previously undescribed species of rail was taken at San Blas, and the distribution areas of a number of species were very considerably enlarged. The occurrence in this region of such northern migrants as Costa’s Hummingbird, Grinnell’s Water-Thrush, and the Common Tern occasioned no surprise, but the discovery of the Flammulated Flycatcher as a breeding bird of the Mazatlan area, and the presence there of the Yucatan Rough-winged Swallow aroused more interest. In several cases, also, the external and internal condition of a bird made it evident that the breeding season of the species was considerably more prolonged than had been previously supposed.

In the various places visited, every courtesy was extended by the Mexican officials. The work was particularly facili-
ated by the efforts of Señor Jesus Gonzales Ortega, of the Dirección de Estudios Biológicos, Mazatlan, Sinaloa; Señor J. Lopez Galindo, Secretario de la Colonia Penal, Maria Madre; Teniente Coronel Commandante del Resguardo Luis Garcia Guerrero, Maria Madre; and the Captain of the Port of San Blas, Nayarit.

In the course of the preparation of this paper, the writer visited museums in eastern United States for the purpose of studying comparative material. The courtesies extended by Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution; Dr. Charles W. Richmond, of the U. S. National Museum; Dr. Harry C. Oberholser, of the Biological Survey; Dr. Frank M. Chapman, of the American Museum of Natural History; and Dr. C. E. Hellmayr, of the Field Museum, greatly aided the work.

To Professor G. F. Ferris, of Stanford University, the writer is indebted for assistance rendered in the field.

The opportunity for collecting the material and preparing the report upon it has been afforded by Dr. Barton Warren Evermann, director of the Museum, California Academy of Sciences, and Mr. Joseph Mailliard, curator of the Department of Ornithology and Mammalogy.

List of Species

1. **Ortalis wagleri** (Gray). Wagler's Chachalaca

In the heavy growth about Labrados, Wagler's Chachalacas were not uncommon. The call note was often heard, but the bird itself was difficult to sight in the crowns of the trees. Frequently its presence was revealed by its heavy flight. This species was said by hunters to be common about San Blas, and one was kept as a pet by the family occupying the house adjoining the hotel, but none was seen in the wild state.

A female in the collection was taken near the estero at Labrados, September 21. It is in worn plumage, but feather renewal is in progress on both upper and under parts. The eighth and ninth primaries are not fully developed, and one pair of lateral rectrices is still in the sheath. The remaining feathers of the tail are still to be renewed.
2. **Lophortyx douglasii douglasii** (Douglas). Elegant Quail

A pair of these birds was noted occasionally in the roadway near Labrados, and covies were heard at intervals in the scrub bordering the pathways. A female, believed to be of this species, with a large brood of young (one of which was collected) was flushed from the branches of a wayside shrub near the estero. No birds of this species were observed at San Blas.

The female taken at Labrados, September 23, was in fresh plumage, only a few feathers of the under part being still in the sheath. The first contour feathers of the juvenile taken on September 28 are just beginning to appear. The outer two primaries are emerging from the sheath, while the head, abdomen, and tibia are still clad in down. The stage of plumage development of this example probably indicates that it is a member of a second brood. Batty\(^1\) found the breeding season to be in April and May; and, at San Blas, Bailey\(^2\) believed that a few of the birds had paired by May 17.

3. **Chlorœnas flavirostris madrensis** (Nelson).
   Tres Marias Pigeon

A few of these pigeons were noted in the tall timber bordering the trail to the salinas on Maria Madre. They flushed easily, and flew with a loud beating of wings which startled all the other birds in the vicinity. No specimens were secured.

4. **Melopelia asiatica mearnsi** Ridgway.
   Western White-winged Dove

These doves were fairly common at all places visited, although fewer were seen at San Blas. The collection includes an unsexed example taken at Labrados, September 23; a female at San Blas, October 14; and a male and female on Maria Madre, October 23.

The unsexed bird from Labrados has acquired new rectrices, but the outer two primaries are little developed and pin feathers are present on all areas. The immature female from

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Maria Madre has the feather renewal only just commenced, the inner three primaries being newly developed. The other birds have nearly completed the postnuptial moult.

5. *Scardafella inca* (Lesson). Inca Dove

Inca Doves were seen occasionally about Labrados, where a male was taken on September 19. Postnuptial moult of the body plumage is nearly complete, but the outer four primaries and most of the rectrices are still to be renewed.


Mexican Ground Dove

Mexican Ground Doves were numerous in the weed-grown areas in the environs of Mazatlan and San Blas, and were frequently seen dusting themselves in the roadways about Labrados and on Maria Madre. They were generally seen in pairs, and were said to be nesting still at Labrados on September 25. The female secured on Maria Madre, October 21, had a fully developed egg in the oviduct.

The three females in the collection were taken at Labrados, September 18; San Blas, October 14; and Maria Madre, October 21. The postnuptial moult of the example from Labrados is almost complete, although the outer two primaries are still in the sheath. The specimen secured at San Blas is an immature with the scapulars and inner secondaries much worn, but showing no indications of feather replacement. The one taken on Maria Madre is in unworn plumage.


Vinaceous Ground Dove

These ground doves were to be seen along the roadways and in the low growth of the partially cleared fields about San Blas. They occurred most frequently in the *campo* to the north of the town.

Two males were taken on October 3 and 6. One example is in fresh feather, save for the scapulars and a few inner secondaries. Moult has only just begun in the other specimen. Pin feathers are present on the under parts, and a few of the outer secondaries and inner primaries have been replaced.
8. **Leptotila fulviventris angelica** Bangs & Penard.  
   White-fronted Dove

   Birds of this species did not appear to be common about San Blas, but a few were observed in the heavy growth flanking the Tepic road. One female, in fresh winter livery, was secured on October 19.

9. **Leptotila fulviventris capitalis** Nelson.  
   Tres Marias Dove

   These doves were fairly numerous on Maria Madre, the woods bordering the trail to the salinas seeming particularly attractive to the species. No examples were collected, however.

10. **Rallus nayaritensis** McLellan, new species.  
    Nayarit Rail

   The one clapper rail collected at San Blas seems, in spite of the bird's slight immaturity, to be possessed of characters warranting it receiving a new specific name.

   **Diagnosis:** Breast uniform vinaceous cinnamon; white flank bars narrow (1 mm. or less in width); upper parts grayish olive, broadly streaked with fuscous black; greater and lesser wing-coverts superficially Saccardo's umber; wing about 130 mm.; tarsus and middle toe subequal, the length of the former contained about 2½ times in that of wing.

   **Description:** Forehead, crown, and occiput fuscous, slightly paler anteriorly, and posteriorly, like cervix, somewhat suffused with light grayish olive; interscapulars, scapulars, tertials, inner secondaries, rump, and upper tail-coverts fuscous black, more or less broadly margined with grayish olive; primaries, their coverts, and distal secondaries fuscous black; greater and lesser coverts superficially Saccardo's umber; rectrices fuscous black, obsoletely margined with grayish olive; supraloral stripe white, tinged with pale vinaceous cinnamon; lores, auriculars, and side of neck deep mouse gray, shaded on the ventral margins with pale vinaceous cinnamon; breast vinaceous cinnamon, becoming paler posteriorly, and passing into white on chin and throat; abdomen pale creamy white; sides, flanks, crissum, and central under tail-coverts
grayish brown narrowly barred with white, the bars being about 1 mm. in width, the interspaces from 4 to 7 mm.; lateral under tail-coverts white irregularly marked with fuscous black; tibia pale ochraceous buff on proximal surface and light grayish brown on the distal one; under wing-coverts deep neutral gray irregularly barred with white and pale vinaceous cinnamon.

**Measurements:** Wing, 129.0 mm.; tail, 54.6; tarsus, 50.0; tarsal diameter, 6.75; middle toe, without claw, 49.0; culmen, 59.6; depth of bill at base, 12.4; depth of bill at nostril, 7.3.

**Type:** No. 28184, Mus. Calif. Acad. Sci.; collected by M. E. McLellan at San Blas, Nayarit, Mexico, October 19, 1925.

The type specimen is an unsexed immature bird, in recently assumed winter dress. The contour plumage is unworn, and pin feathers are present on all the body feather tracts. All the flight feathers appear to have been newly developed, and the outer five primaries and the central rectrices are still in the sheath. It is believed, however, that the development of these feathers is almost at its maximum, as the calamus is horny and the pulp apparently withdrawn.

Geographically, *Rallus nayaritensis* is nearest to *Rallus yumanensis*, but the latter, in worn plumage, has much paler upper parts, broader white flank bars, and shorter culmen and toes. From *Rallus pallidus*, the San Blas bird differs in its darker upper parts, paler breast, and longer culmen. *Rallus levipes* is a more highly colored bird with proportionately shorter culmen, tarsus, and toes. The lack of rusty on the scapulars and interscapulars, the white supraloral stripe, narrow white flank bars, and proportionately shorter culmen, tarsus and toes distinguish the new species from *Rallus obsoletus*. *Rallus longirostris saturatus* displays broader mesial stripes and more olive margins on the interscapulars, broader white flank bars, and a breast somewhat suffused with olive, and has relatively shorter toes.

It is not improbable that an examination of a series of specimens from the San Blas region would prove *Rallus nayaritensis* to be but a subspecies of *Rallus longirostris*. Dr. Harry C. Oberholser, of the U. S. Biological Survey, who was kind
enough to examine the type, believed that it should be so regarded. Evidence at the disposal of the desriber, however, does not seem to establish fully the fact of intergradation.

11. Aramides axillaris Lawrence. Venezuelan Mangrove Rail

Although the movements of a fair-sized bird were occasionally manifest in the swampy area bordering the Tepic road near San Blas, it was not until October 29 that one of the birds was finally sighted among some half-submerged branches. When the first specimen was being retrieved, it was discovered that the branches still sheltered several of these rails, and another specimen was secured. Although representatives of this species are scarce in collections, it is believed that the habits of the bird, and not its rarity, are responsible for this condition.

The plumage of the immature male and female collected is unworn on all areas, and appears to have been recently acquired.

12. Fulica americana americana Gmelin. Coot

About a dozen Coots were present on the waters of the salinas at the southern end of Maria Madre, and others were seen on the temporary pools near the corrals about a mile north of the settlement. This appears to be the first time that this species has been seen on the Tres Marias.

The two females obtained at the salinas on October 25 are birds in fresh winter plumage.

13. Sterna hirundo Linnaeus. Common Tern

Common Terns do not appear to have been recorded previously from this region, but a female of this species was obtained from a flock present on the ocean shore at San Blas on October 2. The example is seemingly assuming its second winter plumage. The anterior portion of the crown and lores, and the forehead are white intermixed with black, and the remiges are unworn; the remainder of the plumage is that of the preceding summer.
14. **Haematopus palliatus frazari** Brewster. Frazar’s Oyster-catcher

The ocean shore from the town of San Blas southward to the ensenada of Matanchen was a resort for oyster-catchers. They were first noted October 2, and were seen at intervals throughout the month. They were more wary than most of the shore birds, and winged their way out to sea at the approach of an observer. No specimens were taken.

15. **Pagolla wilsonia beldingi** Ridgway. Belding’s Plover

From among the swarms of shore birds frequenting the beach at San Blas, one male of this species was taken October 2. Others were noted at Labrados, and on the marisma at San Blas. The specimen in hand has newly acquired its flight feathers and most of the wing-coverts, and new and partially developed feathers are present on all areas of the body.

16. **Oxyechus vociferus vociferus** (Linnaeus). Killdeer

Shore birds were numerous at the temporary pools situated about a mile north of the settlement on Maria Madre. Killdeer were noted among the assemblage October 26, and one female was collected.

17. **Himantopus mexicanus** (Müller). Black-necked Stilt

The tidal flats at Labrados, and the marisma at San Blas, swarmed with Black-necked Stilts. They were also seen at the salinas on Maria Madre October 25. Specimens were collected at San Blas October 19, but the skins were not preserved.

18. **Numenius americanus** subspecies

Birds believed to be of this species were occasionally seen at Labrados and San Blas, and one was also noted near the lighthouse on Maria Madre October 21. No specimens were secured.
19. *Catoptrophorus semipalmatus inornatus* (Brewster). Western Willet

With the Black-necked Stilts, Western Willets were very abundant on the playa at Mazatlan and at the marisma at San Blas. The skin of the one specimen taken at San Blas, October 19, was not preserved.

20. *Totanus melanoleucus* (Gmelin). Greater Yellow-legs

A number of these birds were present at the estero at Labrados, and a male assuming winter garb was taken September 22. The flight feathers, save for the inner two secondaries, are new. Some worn feathers are still retained among the wing-coverts, and fresh feathers are only just appearing in the contour plumage.

21. *Totanus flavipes* (Gmelin). Yellow-legs

Yellow-legs were noted among the shore birds at Labrados and San Blas, and one female was taken at the marisma at San Blas October 19. The flight feathers of this example have been newly acquired. Moult of the contour plumage has only just begun, pin feathers being present on all areas.

22. *Heteroscelus incanus* (Gmelin). Wandering Tatler

A few Wandering Tatlers were seen on the beach north of Mazatlan, between September 12 and 17, and others were present at San Blas. No specimen of this species was collected.

23. *Actitis macularia* (Linnaeus). Spotted Sandpiper

During a few days spent at Mazatlan (September 12 to 17), and at San Blas, a few of these birds were observed. None was collected.
24. *Ereunetes mauri* Cabanis. Western Sandpiper

This sandpiper was present in large numbers at Labrados and San Blas. One specimen was taken at Labrados September 22. It is a bird in fresh winter plumage, only a few feathers on the head and throat not being fully developed.


The temporary pools about a mile north of the settlement on Maria Madre attracted many shore birds, and from among them one Pectoral Sandpiper was taken October 26. Except for some worn interscapulars, it is a bird in fresh winter dress.


A pool to the north of the wireless station on Maria Madre was found to be a resort for a number of these birds, and an immature female was taken there October 26. A few of these ibises were present on the marisma at San Blas October 29, but the only bird shot was not retained in the collection.

27. *Guara alba* (Linnaeus). White Ibis

“Croak-croaks”, as they are known to the natives, were very abundant in the vicinity of San Blas. Small flocks were to be seen in the mangroves bordering the esteros, and they were present in hundreds on the marisma flanking the Tepic road. At feeding time they whitened the tidal flats as far as one could see, and, if disturbed, flew off heavily to the nearest mangroves. Birds in adult and immature plumage were both included in the flocks, but young birds were decidedly in the minority.

The collection comprises three females and one male taken at San Blas, October 5, 6, and 7. An adult female is in worn dress, but a few new feathers are appearing on the forehead. Two immature females, probably acquiring the plumage of the second winter, have the moult of the flight feathers well advanced. One is developing an eighth and the other a ninth primary. The body plumage is being renewed, and, on one of the specimens, dark shaft lines persist on the newly acquired feathers of the head and neck. The wings of these three females all bear four dark-tipped primaries. The one male is
a hornotine in worn contour plumage. The remiges, save for the outermost, appear unworn, and a few new feathers are being developed on the head and neck.

28. *Ajaia ajaja* (Linnaeus). Roseate Spoonbill

The first Roseate Spoonbill was noted at San Blas October 4, when one was seen feeding on a sandbar in the estero to the west of the town. A second bird was discerned flying over the marisma October 12. On October 17, a visit was paid to a laguna several miles north of the town, and, there, in a spot little disturbed by river traffic, scores of these birds were found in the mangroves, where they rested like gigantic pink blooms. They were very unsuspicious, and even after the first shot was fired, they flew only a short distance before alighting.

One immature and three adult males were collected October 17. A moult involving all feather tracts is in progress. The incoming feathers on the head and neck of the adult birds are pale rose pink, although the worn ones are pure white.

29. *Mycteria americana* Linnaeus. Wood Ibis

But two Wood Ibises came under observation at San Blas. They were found in mangroves overhanging a small estero to the north of the town. Although they were said by the natives to be very difficult to approach, no trouble was experienced in obtaining one of the birds as a specimen. The example is an adult female acquiring winter plumage. Several of the rectrices are new, and the central ones are only partially developed. The outer primary is worn, the next two are still pulpy basally, and the proximal secondary is in the same condition. Apparently moult has not commenced in the contour plumage.


Mexican Great Blue Heron

Several great blue herons had their hunting grounds on the margins of the Labrados estero, and many others were seen among the mangroves at San Blas. One immature female was taken at Labrados on September 28.
31. Casmerodius albus egretta (Gmelin). Egret

A few of these birds were noted at each visit paid to the estero at Labrados. At San Blas they were quite common, and many of the villagers kept them as pets. Although the plumes were offered for sale openly in Mazatlan, the Mexican government does not permit the birds to be collected for scientific purposes.

32. Florida cærulea (Linnaeus). Little Blue Heron

Birds of this species were quite numerous about San Blas, where they were to be seen commonly on the banks of the esteros. They were also frequenters of the marisma and the flooded portion of the Tepic road. One bird had a definite stretch of road which it was seen to patrol daily during the hours when the water covered it. One adult female in fresh winter plumage was taken October 5.

33. Hydranassa tricolor ruficollis (Gosse). Louisiana Heron

Louisiana Herons were quite abundant at the estero near Labrados, and many of them were seen about San Blas. They were less wary than the other herons, and would feed undisturbed within a few feet of a passer-by.

Two immature males and an unsexed hornotine were collected at Labrados September 25 and 26, and an adult male at San Blas October 4. The unsexed bird is in its first contour feathers and there is no indication of moult. The immature males have fresh feathers appearing on the body feather tracts, and the adult male has the outer three primaries and a pair of rectrices still in the sheath.

34. Nycticorax nycticorax naevius (Boddaert). 

Black-crowned Night Heron

It was only occasionally that night herons were seen among the mangroves at Labrados and San Blas. The one female secured at Labrados September 26 is undergoing a postnuptial moult.
35. **Butorides virescens virescens** (Linnaeus). Green Heron

Just one Green Heron was seen at Labrados, but they were numerous at San Blas, where they were commonly to be seen climbing among the roots and branches of the mangroves.

The female taken at Labrados, September 25, is a bird in its first contour plumage, and filaments of down still adhere to some of the interscapulars and wing-coverts. The example taken at San Blas October 7 is an immature female acquiring its first winter plumage, undeveloped feathers being present on all the body feather tracts.

36. **Dendrocygna autumnalis** (Linnaeus).

Black-bellied Tree-duck

Birds of this species were said to be numerous in the vicinity of San Blas, and they are occasionally kept in captivity by residents of the town. A downy young, less than a week from the shell, was presented to me by Señor Reynaud October 8. This example has the neossoptyles on all areas minutely tipped with black.

37. **Phalacrocorax vigua mexicanus** (Brandt).

Mexican Cormorant

A few Mexican Cormorants were generally to be found in the mangroves bordering the esteros at Labrados and San Blas. The skin of the female collected at San Blas October 3 was not preserved.

38. **Sula piscátor** (Linnaeus). Red-footed Booby

The estero at Labrados was apparently a favorite resort of Red-footed Boobies. The low growth at the margin of the water frequently harbored hundreds of these boobies, and at low tide their presence gave the semblance of snow drifts to the uncovered sand bars. They shunned human society and took flight at the slightest provocation. A flock of these birds on the wing—the snowy bodies and dark-tipped pinions silhouetted against the tropical sky—made a never-to-be-forgotten picture.
39. **Sula nebouxii** Milne-Edwards. Blue-footed Booby

Blue-footed Boobies were seen fishing at sea between San Blas and Maria Madre October 20 and 26. A dead bird was also picked up on the beach at San Blas October 2.

40. **Sula brewsteri** Goss. Brewster’s Booby

None of these boobies was noted at sea, but the remains of a dead one was found at the salinas on Maria Madre October 25.

41. **Fregata**, species

Man-o’-war-birds were generally soaring overhead, looking like great hieroglyphics outlined against the sky.

As no specimens were secured, it is impossible to say whether these birds belonged to the *magnificens* or *minor* group. Seven examples at hand from Clarion and San Benedicto islands, Revillagigedo Islands, are referable to *Fregata minor ridgwayi*, as defined by Lowe⁸. One male, however, obtained on San Benedicto on the same day and in the same breeding area as six other specimens, possesses a wing-bar, but has iridescent purple interscapular plumes. This bird is not fully adult, as the feathers of the breast have a grayish cast.

42. **Pelecanus occidentalis californicus** Ridgway.

California Brown Pelican

“Professor Birds”, as they are known to the Mexicans, were always in evidence along the Mexican coast. They sailed about with a most dignified mien among the rollers near shore, and fished in the esteros. They roosted abundantly on Piedra Blanca, off San Blas, and in the trees on the islets in the ensenada of Matanchen. An immature female was taken near the north point of the ensenada on October 11.

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⁸ *Novitates Zoologicae*, XXXI, pp. 279-313.
43. **Cathartes aura septentrionalis** Wied. Turkey Vulture

Among the numbers of Black Vultures present at San Blas, a single Turkey Vulture was noted on two occasions. They were more numerous on Maria Madre, the flocks on the beach in front of the settlement being largely of this species. No specimens were included in the collection.

44. **Coragyps urubu urubu** (Vieillot). Black Vulture

Black Vultures were common at all the points visited, although they were not numerous on Maria Madre. Nelson does not accord this species a place in his list of the birds of the Tres Marias Islands, but they were found in company with the Turkey Vultures on the playa in front of the settlement. The only specimens taken were two males secured at Matanchen, near San Blas, on October 11.

45. **Polyborus cheriway auduboni** Cassin.

Audubon’s Caracara

Only one of these birds was noted on the tide lands at Labrados. Another was seen on the seaward side of Blanca de Tierra Point, and they were found occasionally on the ocean shore at San Blas.

A female was collected at Labrados on September 23. Feather replacement is in progress. Black feathers are interspersed among the worn brown ones of the crown, lower back, and wing coverts. The ninth and tenth primaries are not fully developed, and a pair of lateral tail feathers are in a similar condition. A couple of inner secondaries and the tertials are still to be replaced.

46. **Polyborus cheriway pallidus** Nelson.

Tres Marias Caracara

Caracaras were exceedingly abundant about the settlement and in the clearings near the shore on Maria Madre. They were seen singly and in flocks numbering from 12 to 20. The numerous tufts of feathers of small birds encountered seemed to indicate one source of food supply for the caracara.
The plumage of the immature male secured on October 21 was a good deal worn. New feathers, however, are developing on all areas of the body, and replacement of the secondaries has commenced.

47. Asturina plagiata plagiata (Lichtenstein).
Mexican Goshawk

Several of these hawks were in evidence about Labrados. One was observed in the vicinity of the estero, and frequently another was seen in flight over a weed-grown field near the station. An unsexed juvenile was collected near the railroad track September 19, and on the previous day an immature male was obtained in a clearing near the hacienda.

The young male is beginning to assume its cinereous plumage. Many fresh feathers of this color, some of them edged with cinnamon, are to be found among the scapulars and wingcoverts. The other bird is apparently younger. No moult is in progress, and no ashy feathers have made their appearance.

The proportionately long tail observed by Miller in the immature examples from ESCuinapa, is found in the Labrados birds. The wing and tail measurements of the specimens at hand are: Wing, 282-257; tail, 197-184.

48. Urubitinga anthracina anthracina (Lichtenstein).
Mexican Black Hawk

Although not abundant at San Blas, several of these hawks were observed in the neighborhood and two females were taken October 9 and 15.

The immature bird, although exhibiting slight wear of plumage, shows no indications of feather renewal. The older bird is probably not fully adult, since a few of the scapulars and interscapulars are narrowly margined with rusty. A complete moult is in progress, and fresh feathers on the upper parts lack the rusty margins.

49. Falco rufilgularis, subspecies

A female white-throated bat falcon was collected from the branches of a dead tree at the edge of the marisma at San Blas, October 13. The lookout point had evidently been a satisfactory one, as the crop was filled with dragon-fly bodies.

This example appears to be an immature bird assuming winter garb. Newly developed feathers of the crown are slate-black or black; and those of the interscapular region are blackish slate with a black shaft line, and are obsoletely barred with slate black. The throat and forebreast are white, only slightly tinged posteriorly with cinnamon buff. Fresh feathers appearing on the outer margin of this area are a decided cinnamon buff, but those of the central portion are paler. Unworn feathers of the breast are black, tipped and banded with pale cinnamon rufous. The measurements of this specimen are: Total length, 247.0 mm.; wing, 195.0; tail, 96.0; bill from cere, 12.5; tarsus, 34; middle toe without claw, 31.5.

The status of the bird from the northwestern coast of Mexico is somewhat doubtful. Neither the bird in hand nor the description given by Baird, Brewer, and Ridgway\(^5\) of the adult male from Mazatlan, agrees in color or measurements with the description of *Falco rufilgularis petoensis*\(^6\) from Yucatan. Lack of comparative material makes the expression of an opinion regarding the systematic position of these birds inadvisable, but it is to be noted that Todd and Carriker\(^7\) recognize the Bolivian race only as distinct, while Bangs and Barbour\(^8\) are unable to detect any geographical variation in the species.

50. Cerchneis sparveria, subspecies

On two occasions during the week spent on Maria Madre, birds of this species were found in the vicinity of the wireless station. The pair seen October 26 were under observation for nearly an hour, but no specimen was taken.

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\(^6\) Chubb, Bull. B. O. C., XXXIX, p. 22.

January 31, 1927
51. **Pandion haliaëtus carolinensis** Gmelin. American Osprey

Ospreys were common along the estero to the west of San Blas. Every commanding position at the turns of the river was occupied by one of these birds. They were very difficult to approach, however, and the adult male secured October 17 was the only one obtained.

52. **Glaucidium brasilianum ridgwayi** Sharpe.

Streaked-crowned Pygmy Owl

A bird thought to belong to this species was observed in a wayside tree in the hilly region to the east of San Blas. The momentary glimpse obtained was hardly sufficient for positive identification.

53. **Ara militaris mexicana** Ridgway. Mexican Green Macaw

Although birds of this species were said to breed in the vicinity of Labrados, none was seen during the time spent there. At San Blas, a noisy flock was occasionally seen flying high overhead. Others were heard in the dense jungle bordering the Tepic road, where the fruits of the coquito palm and wild fig proved a great attraction to these birds. Their exceeding wariness made close approach impossible, and no specimens were taken.

54. **Eupsittula canicularis** (Linnaeus). Petz’s Paroquet

Petz’s Paroquets were quite abundant at Labrados, and large flocks were attracted to the vicinity of the hacienda by the fruit of a wild fig tree growing there. At San Blas, they were found indifferently in the swamps and in the hilly region eastward of the town. At dawn and at sunset their calls were to be heard high overhead as the birds made their way to and from favorite feeding grounds.

Fourteen specimens were collected. Two males and three females were taken at Labrados September 20, 25, and 26, and four males and five females were secured at San Blas October 12, 13, 14, and 16. A moult involving the contour and flight
feathers is in progress on a male taken at Labrados September 20. A female taken the same day is in almost entirely fresh feather, only a few pin feathers being present, and the distal primary and two lateral rectrices being undeveloped. The moult of the San Blas birds is further advanced. In most instances the renewal of plumage is almost complete. Three females, however, have been slower in acquiring new livery, and still have flight feathers not fully developed.

55. *Psittacula cyanopygia cyanopygia* Souancé. Mexican Parrotlet

Parrotlets were discovered in but one spot near San Blas—the fields north of the town. Large flocks apparently frequented certain tall trees bordering the open ground. The presence of the birds was difficult to detect, and dead birds proved almost impossible to retrieve from the tall grass and weeds into which they fell.

A male and female were taken October 14. The male is a young bird which has just assumed its first winter plumage, a few pin feathers being present on the crown and throat. The contour plumage of the female is being renewed, two central rectrices are new, and three distal primaries and some inner secondaries have still to be replaced.

56. *Amazona oratrix tresmariae* Nelson. Tres Marias Parrot

These birds were fairly common on Maria Madre, and they were seen in pairs or in flocks on all parts of the island. The persecution to which they have been subjected at the hands of the residents has made these parrots very adroit in avoiding danger, and, although they proclaimed their presence by noisy cries, they took wing on the slightest hint of peril. A single adult female was taken October 24.

57. *Amazona finschi* (Sclater). Finsch's Parrot

Parrots of this genus were observed flying high above Labrados, and they were noted in greater numbers about San Blas. The only Finsch's Parrot in the collection, however,
was taken at the marisma near San Blas October 12. The bird is a male which is just experiencing a complete moult. The tenth and eighth primaries and several of the lateral rectrices are still to be replaced.

58. *Amazona albifrons albifrons* (Sparrman).

White-fronted Parrot

Among the flocks of Amazonæ seen at Labrados, at least one of them was composed of birds of this species. Probably many others were present, but they were not always distinguishable from birds of the preceding species. This was also true at San Blas.

An adult male taken October 19, and a female secured October 17 are in the collection from San Blas. The female is in completely fresh livery, but a few pin feathers are present on the head and throat. The outer primaries of the male are just appearing from the sheath, and a few partially developed feathers are in evidence on other areas.


Ringed Kingfisher

Ringed Kingfishers were apparently rare at San Blas, and only two were noted on the western estero, where the one specimen—an adult female—was taken October 17. The plumage of this example is much worn on all areas, save for four proximal primaries, several distal secondaries, and one lateral rectrix which have been newly acquired. All the feathers of the upper parts are distinctly spotted with white, and the outer webs of the secondaries are conspicuously barred with white on the outer webs.

60. *Megaceryle alcyon caurina* (Grinnell).

Northwestern Belted Kingfisher

Only one bird of this species was noted at Labrados, but there were many on the esteros at San Blas, as well as about the flooded areas abutting on the Tepic road. On October 26,
one was seen on the wires attached to the pier on Maria Madre.

An adult and two immature females were collected at San Blas October 12, 13, and 17. The birds are all in worn plumage, but replacement has commenced among the remiges, and new feathers are appearing on the crown.

61. Chloroceryle americana septentrionalis (Sharpe).
   Texas Kingfisher

This bird was common on all the waterways about San Blas, the Tepic road seeming to be a particularly profitable fishing ground for them. An immature male and female were secured on October 12, and an adult male on October 13.

The female exhibits no indications of moult and its plumage is in good condition. Both males are renewing the flight feathers, and the immature bird has many chestnut-rufous tipped feathers appearing on the breast.

62. Momotus mexicanus mexicanus Swainson.
   Mexican Motmot

The only motmot seen about San Blas was discovered, October 16, in the deep jungle bordering the Tepic road. It proved to be an adult male with moult of the contour feathers in progress, but the flight feathers unaffected. The crop contained the remains of many beetles.

63. Nyctidromus albicollis insularis Nelson.
   Tres Marias Parauque

Tres Marias Parauques seemed numerous on the island, and they were frequently flushed in dry arroyos and on shady paths. The collection comprises a male and three females taken October 23 and 24. In all cases the assumption of winter dress is nearly complete. The plumage of these specimens is decidedly darker than that of birds taken in May. The upper parts are strongly suffused with Rood’s brown, and the anterior under parts are tinged with vinaceous-fawn.
64. **Amazilia rutila rutila** (Delattré).  
Cinnamomeus Hummingbird

The Antigonon festooning the wayside shrubs about Labrados attracted numbers of these hummingbirds. At San Blas hummingbirds were fewer, and birds of this species were rarely seen save in trees supporting a growth of Loranthus.

The collection includes two males and two females taken at Labrados September 19, 22, and 27; and four males secured at San Blas October 3, 8, and 16. All the examples are experiencing feather replacement. A female taken at Labrados September 19 has almost completed its feather renewal. Another female secured on the same day retains a worn distal primary and two tertials, and has all the rectrices still in the sheath. Save for a few undeveloped feathers in the contour plumage, two males taken at San Blas October 3 and 8 have completed their moult. Another male collected October 16 has the outer two primaries still in the sheath and most of the rectrices only partially grown.

65. **Amazilia graysoni** Lawrence.  
Grayson's Hummingbird

The field notes of the California Academy of Sciences’ party visiting Maria Madre in May, 1925, indicated that birds of this species were common on the island. Few were seen in October, however, and they were on the western slope of the island and in the vicinity of the salinas. No specimens were secured.

66. **Amazilia ellioti** (Berlepsch).  
Black-billed Azure-crown

This hummingbird was not abundant at Labrados, but several were noted, and four males were collected on September 22, 24, 25, and 26. In the vicinity of San Blas one example only was seen. It was taken on October 16, but the skin was not retained in the collection.

Postnuptial moult is almost complete in the specimens at hand. In two cases the outer primaries are not fully de-
veloped, and a few pin feathers are present in the contour plumage of all the birds.

67. **Cyanthus latirostris** Swainson.

Broad-billed Hummingbird

Wherever the Antigonon blossomed about Labrados, Broad-billed Hummingbirds were to be found. They were less numerous at San Blas, where they frequented the clumps of Loran-thus in company with the Cinnamomeus Hummingbird.

Seven males and one female were taken at Labrados on September 19, 21, 22, 25, and 27. Three of the males have almost completed the fall feather replacement. The remainder have a few undeveloped contour feathers, and outer primaries still in the sheath. The female has the central rectrices only partially developed.

68. **Cyanthus lawrencei** (Berlepsch).

Lawrence’s Hummingbird

This species appeared to be the abundant hummingbird on Maria Madre. The Antigonon wreathing the scrubby growth on the eastern side of the island attracted them in numbers, and they also appeared in the gardens in the settlement. The adult male secured on October 22 is a bird in fresh winter plumage.

69. **Anthoscenus constantii leocadiae** (Bourcier & Mulsant).

Pine Star-throat

Only three birds of this species were seen at Labrados. The specimen secured September 27 is a female in unworn plumage.

70. **Zephyritis costae** (Bourcier). Costa’s Hummingbird

One female Costa’s Hummingbird was taken at Labrados September 27, but no other representative of the species was observed. The example is apparently an immature bird assum-
ing its first winter plumage. New feathers are appearing on the crown and back, and a few inner remiges are unworn.

This hummingbird does not appear to have been taken so far south since it was first recorded from the Mazatlan region by Ridgway10 in 1880.

71. *Troganurus ambiguus ambiguus* (Gould).  
Coppery-tailed Trogon

An unsexed hornotine of this species was taken in the deep woods near the Labrados estero on September 24. This was the only Coppery-tailed Trogon discovered in the vicinity, and none was noted at San Blas. The specimen secured appears to be a young male acquiring its first winter plumage.

Goldman’s Trogon

In the heavy timber clothing the higher levels of Maria Madre, these trogons did not seem to be uncommon. So exceedingly quiet were they that their presence was usually detected by chance.

A juvenile male and an immature female were secured on the western slope of the island October 24. The male has newly developed metallic feathers on the crown and the remiges appear fresh, but the tail feathers are much worn. Save for abraded rectrices, the plumage of the female is in good condition. A few pin feathers are present on the body feather tracts.

73. *Trogon citreolus* Gould. Citreoline Trogon

Only one Citreoline Trogon was seen at Labrados, but at San Blas they were fairly abundant in the heavy timber. They were noted near the Tepic road, in the vicinity of Camaron Point, and between the ensenada of Matanchen and La Palma.

An adult male taken at Labrados September 18 has renewal of the contour feathers well advanced. The inner four second-

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aries and outer four primaries are still to be replaced, and new rectrices are being developed. The immature male and female collected at San Blas October 13 and 29 seem to be undergoing a complete moult. Replacement of the contour feathers is nearly finished, and the male possesses new rectrices.

74. **Coccyzus minor palloris** Ridgway.

Pacific Mangrove Cuckoo

In the tangle of scrubby growth north of the wireless station on Maria Madre, a single Pacific Mangrove Cuckoo was obtained October 26. The bird is an immature female acquiring its first winter dress. The under parts are deep cinnamon-buff, new feathers being of the same color. The seventh primary appears to be new, as are some of the scapulars. One outer rectrix is about half-grown, and pin feathers are present on all areas of the body.

75. **Coccyzus americanus** (Linnaeus). Yellow-billed Cuckoo

An occasional cuckoo was seen among the mangroves overhanging the western estero at San Blas, but only one bird was taken. It proved to be an immature male of this species. One central rectrix is new, but there is no other evidence of moult.

76. **Piaya mexicana** (Swainson). Mexican Squirrel-Cuckoo

Only three Squirrel-Cuckoos were seen about San Blas. They were all in the summits of tall trees, and their movements among the branches left no doubt as to the reason for the vernacular name.

The adult female collected October 15 has partially developed feathers present on all areas of the body feather tracts. Three new rectrices are in evidence. The tenth, eighth, and fifth primaries are just appearing, and the ninth and seventh seem new. Two distal secondaries are unworn.
77. **Morococcyx erythropygus mexicanus** Ridgway.
   Mexican Rufous-rumped Cuckoo

   The only Mexican Rufous-rumped Cuckoo noted was collected at Labrados September 28. It is a bird-of-the-year assuming its first winter plumage.

78. **Crotophaga sulcirostris sulcirostris** Swainson.
   Groove-billed Ani

   This was one of the most abundant birds in the region traversed, although their numbers were fewer about San Blas. Their raucous voices were nearly always to be heard throughout the day, and some of the calls seemed to be mimetic of those of other birds.

   Three males and two females were collected at Labrados September 19, 21, and 23. One male and female are immature birds acquiring their first winter plumage. Replacement of the contour feathers has just commenced, the rectrices are worn, and the proximal primaries and distal secondaries are being renewed. Three younger birds are only just assuming their first contour plumage. The under parts are still clad in brownish black down, through which the definite feathers are here and there making their appearance. Flight feathers are only partially developed.

   All the birds shot had the pupae of some parasitic insect present subcutaneously.

79. **Centurus uropygialis uropygialis** Baird.
   Gila Woodpecker

   One Gila Woodpecker was obtained from the summit of a Pachyceræus at Labrados, September 25. The bird is an adult male in fresh winter plumage. Two distal primaries are not fully grown, and the central rectrices are still in the sheath.
80. **Centurus chrysogenys chrysogenys** (Vigors).

Golden-cheeked Woodpecker

A number of Golden-cheeked Woodpeckers were seen in the Pachycerei about Labrados. At San Blas they were quite common, and their noisy calls resounded in the village gardens as well as in the jungle.

Two adult males and a female were secured at Labrados September 22 and 27; and six males and four females were obtained at San Blas October 3, 5, 8, 9, 10, 12, 14, and 19. Two females taken at San Blas, October 14 and 19, are in winter garb. One taken October 12 is in worn plumage, but renewal has commenced. Another example secured October 10 retains worn secondaries. The remainder of the San Blas specimens, as well as those from Labrados, have feather renewal well advanced, in most cases the outer two primaries and central rectrices are not fully developed.

81. **Dryobates scalaris graysoni** (Baird).

Grayson's Woodpecker

Grayson's Woodpeckers seemed generally distributed on Maria Madre. They were observed among the second growth scrub on the eastern side of the island, in the dense woods, and among the agaves on the western shore.

A male and two females were collected October 23 and 24. One female is acquiring fresh central rectrices, but the remiges are greatly abraded. Moulting is affecting the wing feathers of the two other specimens, but the contour plumage is that of the preceding season.

Two of the birds have the flanks streaked, the third has streaks on one side and spot-like markings on the other.

82. **Dryobates scalaris sinaloënsis** Ridgway.

Mazatlan Woodpecker

Two Mazatlan Woodpeckers were seen at Labrados, and one of them was collected September 27. The plumage of this bird is in good condition, and there is no evidence of moulting.
83. **Scapaneus guatemalensis nelsoni** Ridgway.

Nelson's Ivory-billed Woodpecker

Several of these noisy birds made their presence known in the woods near the Labrados estero, and they were apparently numerous in the swampy areas about San Blas.

The collection includes a female taken at Labrados September 24, and a male secured at San Blas October 10. Both birds have feather replacement well advanced. The stripe extending from the upper side of the neck to the lower back is maize yellow in the female, and almost pure white in the male.

84. **Ceophloeus lineatus scapularis** (Vigors).

Vigors' Lineated Woodpecker

Birds of this species frequented the higher levels about San Blas, and occurred abundantly in the woods flanking the Tepic road. One female was secured October 29. The contour plumage is unworn, and only the three distal primaries and the tertials are still to be renewed. The rectrices are apparently not new.

85. **Xiphorhynchus flavigaster mentalis** (Lawrence).

Grayson's Woodhewer

A Grayson's Woodhewer was found in the heavy woods near the estero at Labrados, September 24. It was wounded, but escaped to the tangled undergrowth. Two others were seen near San Blas, but no specimen was secured.

86. **Camptostoma imberbe** Sclater. Beardless Flycatcher

On September 25, the persistent chirping issuing from a small bush on the edge of a clearing near the Labrados estero called attention to the presence of a Beardless Flycatcher. When collected, the bird proved to be a juvenile which is just assuming winter dress. New feathers are appearing among the worn ones on the crown, and the outer two primaries are still in the sheath.
I am indebted to Dr. W. DeW. Miller, of the American Museum of Natural History, for determining the identity of the specimen.

87. *Pitangus sulphuratus derbianus* (Kaup).

   Derby Flycatcher

   A few of these flycatchers were noted at Labrados. They frequented the mesquite on the ocean shore at San Blas, and were abundant inland along the Tepic road. The noisy calls made this species one of the most conspicuous features of the bird life of the region.

   Three immature males were collected at San Blas October 3, 7, and 13. The first contour plumage is being replaced by winter dress. The body feathers are being renewed, but apparently not those of the wings and tail.

88. *Pyrocephalus rubinus mexicanus* Sclater.

   Vermilion Flycatcher

   Vermilion Flycatchers were seen occasionally at Labrados, and more abundantly about San Blas. The fields to the north of the latter town, and the territory about the marisma were seemingly most attractive to these birds.

   From Labrados there are five adult males in the collection, taken on September 26, 27, and 28. One adult and one immature female and two immature males were taken at San Blas October 6, 7, 12, and 13. The adult birds have just experienced a complete moult. The female has a rectrix not fully grown, and one male has the outer primary still in the sheath. One immature male is in fresh winter livery, the other immatures have outer primaries and inner secondaries to renew, and one has a central rectrix only partially developed.

89. *Empidonax traillii brewsteri* Oberholser.

   Brewster’s Flycatcher

   The shrubby growth at the estero at Labrados proved to harbor a number of these flycatchers. In that vicinity, three
immature males were collected September 19, 26, and 27. The newly acquired plumage seems to result from a complete moult.

90. *Empidonax difficilis difficilis* Baird.

Western Flycatcher

Western Flycatchers occurred in the more sheltered areas of the San Blas region, where one immature and four adult males and an adult female were collected October 6, 7, 9, and 10. Two of the adult males have fresh flight feathers, and renewal of the contour plumage is nearly complete. The other adults still have distal primaries and proximal secondaries to replace. The immature bird exhibits no indication of moult.

91. *Myiochanes pertinax pertinax* (Cabanis & Heine).

Swainson’s Flycatcher

An immature female, believed to belong under this head, was obtained near San Blas October 13.

92. *Myiochanes richardsonii richardsonii* (Swainson).

Western Wood Pewee

One Western Wood Pewee was secured at Labrados, September 25. The bird is an immature male in its first winter plumage, but the tertials and a few crown feathers are those of the preceding season.

93. *Myiarchus nuttingi inquietus* (Salvin & Godman).

Guerrero Flycatcher

A male of this species was taken in the fields north of San Blas October 7. Winter plumage has recently been acquired.

Arizona Crested Flycatcher

Many of these flycatchers were found among the low growth on the eastern slope of Maria Madre. The male taken October 22 is experiencing postnuptial moult. The outer three primaries and inner two secondaries are still in the sheath, and a few pin feathers are present on the forehead.

95. *Myiarchus lawrenceii tresmariae* Nelson.

Tres Marias Flycatcher

The second growth scrub on the eastern face of Maria Madre harbored many of these small flycatchers. The juvenile male taken October 21 is acquiring fresh livery, new and partially developed feathers being in evidence on all the body feather tracts.


Olivaceous Flycatcher

Olivaceous Flycatchers were present in the mesquite near the ocean shore at San Blas, and also in the vicinity of the marisma. A female collected October 9 has fresh contour feathers, and a few flight feathers not quite fully developed.

97. *Deltarhynchus flammulatus* (Lawrence).

Flammulated Flycatcher

An unsexed juvenile collected at Labrados September 28 proved to be a representative of this rare species. Only five specimens have been recorded previously, and the first contour plumage, worn by this example, has never been described. Above the bird is grayish olive, faintly tinged anteriorly with light greenish olive; feathers of the crown with distinct dark shaft lines, those of the interscapular region having obsolete mesal lines and margins producing a nebulous effect; rump feathers tipped with pale cinnamon buff; upper tail-coverts medially light grayish brown, broadly margined with tawny
olive; rectrices grayish brown, the outer webs margined with tawny olive, the inner ones with pale cinnamon; outermost rectrix pale grayish brown, the outer web and margin of inner one pale grayish buff; primaries, secondaries, tertials, and the wing-coverts chaetura drab; the distal primary narrowly margined with pale grayish buffy, the next two more distinctly edged with cinnamon buff, the inner primaries and secondaries with outer margins clay color and inner ones pinkish buff, tertials margined with warm to light buff; primary coverts narrowly edged with clay color, the greater ones with cinnamon buff, and the lesser with grayish olive; chin and throat grayish white, feathers of all but the mental apex with dark median stripe; forebreast and breast light grayish olive, streaked anteriorly with whitish and posteriorly with primrose yellow, and passing into primrose yellow on the abdomen and under tail-coverts; margin of wing lining pale buffy yellow, interrupted by grayish brown.

In comparison with the specimens of adults in the collection of the U. S. Biological Survey, this juvenile is more distinctly greenish olive above, the medial lines of the crown feathers darker, the lesser wing-coverts more olive, and the streaking of the under parts more pronounced and decidedly gray. Although lacking the intensity of color of an adult female (No. 156020, U. S. Biol. Surv. coll.) from Las Palmas, Jalisco (March 31, 1897), the Labrados bird more nearly resembles it than it does the specimens from Guerrero and Chiapas, and it is possible that the color differences exhibited by the juvenile may be due to geographic as well as age variation.

98. **Tyrannus melancholicus occidentalis** Hartert & Goodson.

San Blas Kingbird

This kingbird was one of the commonest birds at Labrados and San Blas, and on Maria Madre. At San Blas they were found most frequently near the ocean shore, where they hawked for the myriads of insects abounding there.

The collection comprises an adult, an immature male and two immature females taken at Labrados September 18, 19,
and 20; three adult males taken at San Blas October 2, 7, and 8; and one immature female secured on Maria Madre October 21.

All the examples are experiencing feather renewal. Three immatures from Labrados, taken September 18 and 19, are in fresh feather, but some of the primary and lesser coverts have not been replaced. The moult of the immature from Maria Madre has only just begun, and the remaining birds have the plumage in various stages of replacement.

The fresh feathers of the under parts vary in color from light cadmium to apricot yellow.


Gray-headed Tityra

On October 15 and 29 an adult female and male of this species were obtained from the summit of the same tall tree in the jungle near the Tepic road. No others were seen. The postnuptial moult of the female is nearly complete, though some of the remiges are not fully grown and a few undeveloped feathers are present on the body feather tracts. The feather replacement of the male is well under way, but is behind that of the female.

100. *Iridoprocne albilinea* (Lawrence). Mangrove Swallow

Mangrove Swallows frequented the vicinity of the larger esteros about San Blas, and even the outer beach was regarded as good foraging ground. There was no diminution in their numbers by October 30, and no indication of the migratory movement that might have been expected from the field note quoted by Miller\(^1\), "Arrives [in Esuinapa] in April."

Four adult males were secured at San Blas October 3, 5, and 16. One of the birds taken October 16 is in fresh livery. The others have new contour plumage, but one taken October 3 has the outer two primaries and the inner two secondaries to renew. Two of the examples have indications of a pectoral band.

101. Stelgidopteryx ridgwayi Nelson.
Yucatan Rough-winged Swallow

102. Stelgidopteryx serripennis salvini Ridgway.
Salvin's Rough-winged Swallow

The collection comprises three rough-winged swallows from Labrados taken September 17, 18, and 25. One of the specimens corresponds to Nelson's description of Stelgidopteryx *ridgwayi*, the other two appear to be referable to Ridgway's *Stelgidopteryx serripennis salvini*. Examination of the series of Stelgidopteryx in the U. S. National Museum, the American Museum of Natural History, and the Field Museum made the difficulties of the rough-winged swallow problem evident. The collections included few specimens in fresh feather and none in plumage comparable to that of the birds under consideration. The evidence tended to prove the integration of *ridgwayi* with *salvini* and *serripennis*¹², but the occurrence of a typical *ridgwayi* in the Mazatlan region, as well as more or less characteristic examples in Jalisco (May 9), and in central Mexico, suggests that the variations may not be wholly geographical in origin.

103. Polioptila cærulea amoenissima Grinnell.
Western Gnatcatcher

Gnatcatchers were quite numerous in the shrubbery bordering the roads and fields about San Blas. One particular mimosas tree to the south of the town was generally found to have several in its branches. Three female Western Gnatcatchers were taken on October 3 and 14. The bird collected on the 14th is in unworn plumage, only the central pair of rectrices is yet to be renewed. The body plumage of the other examples is fresh, but the flight feathers have not been replaced.

104. Polioptila nigriceps nigriceps Baird.  
Baird’s Gnatcatcher

The trees bordering forest glades near Labrados were found to harbor quite a number of gnatcatchers. An immature female and an adult male secured September 17 and 26 proved to belong to this species. The postnuptial moult of the male is well advanced, but that of the female has hardly begun.

105. Thryophilus sinaloa sinaloa Baird. Sinaloa Wren

At Labrados wrens were occasionally heard, but rarely seen. Although they were more in evidence about San Blas, specimens proved difficult to secure. The collection includes an immature male obtained at Labrados, September 22, and a juvenile and an adult male taken at San Blas, October 6 and 3. The juvenile is in its first contour plumage, and the flight feathers are only partially developed. The auriculars and throat of this specimen are tinged with pale yellow. The plumage of the adult is greatly abraded, but there is no indication of moult.

106. Pheugopedius felix pallidus (Nelson). Durango Wren

An immature female of this species was obtained at San Blas, October 14. The breast and sides are strongly tinged with ochraceous-tawny, passing into pale cinnamon brown on the immaculate under tail-coverts.

107. Pheugopedius felix lawrencii (Ridgway).  
Lawrence’s Wren

Lawrence’s Wrens proved to be abundant and very tame on Maria Madre. So confiding were they that they would approach within a few feet of a spectator, and examine him without the slightest trace of fear. The plumage of a male collected October 22 is greatly abraded. Several of the remiges are worn almost to the rachis, and all but one rectrix has been shed. The contour plumage has been largely replaced, and some of the inner primaries are new. The newly developed feathers of the pilium are antique brown.

Western Mockingbird

Two mockingbirds in full song were discovered in a field near San Blas. No others were seen in the vicinity, but several were found on Maria Madre. The female taken at San Blas October 14 is experiencing postnuptial moult. Renewal of the contour plumage is almost complete, but the distal primaries and inner secondaries have still to be replaced.


Mazatlan Thrasher

The Mazatlan Thrasher collected at Labrados, September 22, was the only representative of the species observed. Post-nuptial feather replacement is nearly complete. A few worn scapulars and interscapulars are present, and the distal primary and three proximal secondaries are those of the preceding season. Some of the rectrices are not fully developed.


Tres Marias Blue Mockingbird

Blue mockingbirds did not appear to be so numerous or so fearless as Nelson\(^1\) found them in 1897. A good many were seen, however, in the less frequented portions of the thicket. They were very quiet in their movements, and no song was heard. The moult of the immature taken October 23 is well advanced.

111. *Turdus rufopalliatus* Lafresnaye. Mazatlan Robin

At Labrados few robins were seen, but at San Blas they were more in evidence. A good many occupied the thicket north of Blanca de Tierra Point, and others were present in the lower growth flanking the Tepic road. A juvenile male taken at Labrados September 18 is assuming winter dress, but there are still many spotted feathers on the throat and breast.

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\(^1\) N. A. Fauna, No. 14, p. 59.
Two adult females secured at San Blas, October 10 and 15, have the feather renewal nearly complete, although pin feathers are present in the contour plumage.

112. **Turdus graysoni** (Ridgway). Tres Marias Robin

Robins were abundant and widely distributed on Maria Madre. Although they seemed to prefer the more open areas on the eastern slope, a few were noted in the heavy timber. Two adult males collected October 22 and 23 are in fresh feather. In this plumage the feathers of the back are dresden brown, the scapulars margined with ochraceous-tawny, and the forehead and crown washed with a pale tint of dresden brown. The sides and flanks are pale buckthorn brown, and the under wing-coverts pale ochraceous-orange.

113 **Hylocichla ustulata ustulata** (Nuttall).

Russet-backed Thrush

One Russet-backed Thrush was obtained at San Blas, October 3. It is a bird in its first winter plumage, and still retains buff-tipped wing-coverts.

114. **Lanivireo solitarius plumbeus** (Coues).

Plumbeous Vireo

Vireos were very rare at all the collecting stations, and the capture of an adult male Plumbeous Vireo at Labrados September 28 was quite unexpected.

115. **Mniotilta varia** (Linnaeus). Black-and-White Warbler

A few birds of this species were noted in the woods flanking the Tepic road, San Blas, and one immature male was collected October 29.
116. *Compsothlypis pitiayumi insularis* (Lawrence).

Tres Marias Warbler

Tres Marias Warblers were met with upon but one occasion on the mainland—in the low growth near the Labrados estero. Upon Maria Madre they were numerous, sharing with the wrens the distinction of being the most abundant species on the island. They seemed to be in full song, and gave voice to a faint but melodious lay.

The collection includes an immature male from Labrados, taken September 24, and an immature and two adult males taken on Maria Madre October 23, 21 and 22. The first winter's plumage of the Labrados bird has been assumed, and the moult of the birds from Maria Madre is complete.

117. *Dendroica aestiva sonorana* Brewster.

Sonoran Yellow Warbler

A male Sonoran Yellow Warbler was captured at Labrados, September 24. A few other examples were noted in that neighborhood, but none was positively identified at San Blas. The specimen in hand is in full winter plumage.

118. *Dendroica erithachorides castaneiceps* Ridgway.

Mangrove Warbler

Only one bird of this species was recognized in the mangroves near the Labrados estero, but at San Blas the growth fringing the marisma sheltered a great number of them.

One immature and six adult males, two females, and one unsexed example were obtained at San Blas, October 9, 12, and 16. Two adult males have outer primaries and inner secondaries still in the sheath, and another has many undeveloped feathers in the contour plumage. The unsexed bird appears to have fresh primaries and secondaries, but the tertials and rectrices have not been renewed. An immature female is in worn livery, but indications of replacement are in evidence in the body plumage. The remainder of the specimens have acquired winter dress.
119. **Dendroica nigrescens** (Townsend).

Black-throated Gray Warbler

An occasional warbler, believed to belong to this species, was noted in the tall timber bordering the Tepic road, and a female and an unsexed bird were obtained October 9 and 16. Both birds are in postnuptial garb.

120. **Dendroica auduboni**, subspecies

Two birds of this species were seen at close range at sea between San Blas and Maria Madre, October 20.

121. **Oporornis tolmiei** (Townsend).

Macgillivray’s Warbler

This warbler was not uncommon in wayside brush and second growth scrub on the mainland. An immature bird was taken at Labrados, September 27; and an immature male, a female, and an unsexed bird were secured at San Blas, October 2, 10, and 14. The immature male has many pin feathers present on the forehead and throat, but the moult of the other examples is complete.

122. **Seiurus noveboracensis notabilis** Ridgway.

Grinnell’s Water Thrush

A male, in postnuptial dress, was taken near the Tepic road, San Blas, October 15. This species does not appear to have been previously reported from this portion of Mexico.

123. **Geothlypis trichas modesta** Nelson.

San Blas Yellow-throat

No yellow-throats were seen at Labrados, but about San Blas they were quite common. The marisma proved to be the headquarters of the species, but some individuals were noted on the peninsula opposite the town. An adult male and four females were taken October 12. One female seems to wear winter dress, but moult is still in progress in the other examples.
124. *Icteria virens longicauda* Lawrence.
Long-tailed Chat

In the vicinity of San Blas a number of Long-tailed Chats were seen. They frequented the bushes in the fields to the north of the town, and several were noted in the deep woods bordering the Tepic road. Two females were taken October 7. No moult is in progress, but the rectrices are unworn, and the outer primaries and the tertials appear to have been renewed.

125. *Granatellus francescae* Baird.
Tres Marias Red-breasted Chat

During the five days spent on Maria Madre only two birds of this species were seen. One was discovered in the deep woods on the western side of the island, and another, which was collected, in the lighter growth by the trail to the salinas. The specimen is an immature male in fresh winter plumage.

Golden Pileolated Warbler

Pileolated warblers were present in considerable numbers at both Labrados and San Blas. An adult and two immature males collected at San Blas. October 8, 22, and 28, have been referred to this form.

127. *Setophaga ruticilla* (Linnaeus). American Redstart

No redstarts were observed at Labrados, but a number of individuals were seen pirouetting and posturing in the quieter woods near San Blas. An adult male and female were collected October 9 and 16.

Western Fan-tailed Warbler

The collection includes two Western Fan-tailed Warblers, which were taken October 15 and 16 in the same spot near the Tepic road, San Blas. They were seeking food about a fallen
log, and gyrated about much as do the redstarts. A sharp *chirp* was uttered at intervals as the birds went through their performance.

129. **Pheucticus chrysopeplus** (Vigors).

Vigors' Grosbeak

Certain trees in the vicinity of Labrados were resorted to by many Vigor's Grosbeaks. Occasionally one was heard uttering a rather pleasing call note, but no true song was produced.

The three immature males secured September 23, 24, and 25 are assuming winter garb. One example has feather replacement nearly complete; the others still retain much of the juvenile plumage.

130. **Cyanocompsa parallina indigotica** (Ridgway).

Turquoise-fronted Bunting

Wayside weeds and shrubs afforded food and cover for numbers of seed-eating birds. From among flocks of these birds two immature males and one immature female of the Turquoise-fronted Bunting were captured September 24, 26, and 27. The autumn moult of one of the males is well advanced. The body plumage appears to be unworn, and new flight feathers are being developed. The other examples seem to belong to a late brood. Replacement of the juvenile plumage has only well begun.

131. **Sporophila torqueola** (Bonaparte).

Cinnamon-rumped Seedeater

Weedy fields to the north and south of San Blas were favorite resorts of these seedeaters. Two adult males and three immature females were secured October 2, 5, 6, and 7. Although the plumage of the males is greatly abraded, a new lateral rectrix being developed by one of them is the only indication of feather replacement. Two of the females are in winter garb, but the third, a much younger bird, has just commenced the moult of the contour feathers.

Blue-black Grassquit

Blue-black Grassquits frequented the corn fields and weed patches about Labrados, but they were so wild that specimens were difficult to secure. One male, too greatly damaged to preserve, was taken September 18, and another male and a female in the collection were secured September 26 and 27. The male is in fresh body plumage, but, save for the tertials and greater and lesser coverts, the flights feathers are much worn. The female is a bird in its first contour plumage.


Tres Marias Cardinal

On Maria Madre, cardinals were exceedingly abundant. They were present in the scrub near shore and in the clearings on the central ridge. An adult male and female were secured October 22. The male is in almost fresh feather. Two proximal secondaries have yet to be shed, and other flight feathers are not fully developed. The female has only just commenced the renewal of the remiges, and the worn rectrices are retained.

134. *Saltator plumbeiceps* Lawrence. Grayson's Saltator

During the collecting period at San Blas, only two of these birds were seen. An adult male was discovered in scrub growth in a field north of the town, and an immature female was shot in the heavy growth near the Tepic road. The female taken October 19 is in fresh plumage. The winter dress of the male is being acquired. The contour feathers and rectrices are new, but inner secondaries and the outer primary have not yet been replaced.

135. *Spiza americana* (Gmelin). Dickcissal

Birds, believed to be Dickcissals, were present in the corn fields about Labrados, but no specimens were taken. At San Blas one of a pair was collected on the Tepic road, October 15; and another example was secured in the mangroves bor-
dering the marisma, October 29. The male still possesses worn tertials and rectrices, but the remainder of the plumage is fresh. The livery of the female appears to be unworn.

136. **Chondestes grammacus strigatus** (Swainson).

**Western Lark Sparrow**

An adult male and an immature female of this species were taken near the railroad station at Labrados, September 21 and 27. The male is in fresh postnuptial plumage, but the female is in worn feather. A few new feathers showing on the forehead are the only indications of renewal.

137. **Passerina ciris** (Linnaeus). **Painted Bunting**

Many Painted Buntings foraged among the wayside weeds, and darted in and out of the bushes at the margins of clearings. Two adult males and two females were secured at Labrados, September 25 and 26, and an adult and an immature male were taken at San Blas, October 16 and 19. An adult male taken on September 26 has the outer primary still in the sheath and many pin feathers present among the contour feathers. The immature male is in fresh body plumage, but inner primaries, outer secondaries, and some of the lateral rectrices have yet to be moulted. A female taken on September 26 has the flight feathers still in the sheath. The other examples have acquired postnuptial dress.

138. **Arremonops superciliosus sinaloae** Nelson.

**Mazatlan Sparrow**

The sweetest songster of the Labrados woods was so shy that he was exceedingly difficult to sight, although the notes frequently announced his presence. When specimens were eventually obtained September 26, they proved to be representatives of this rare form. So far as published records show, only six examples have been taken previously.

The female in hand is in greatly abraded plumage, and moult has barely begun. The male is an immature which is beginning to acquire adult dress.
139. **Euphonia godmani** Brewster. Godman’s Euphonia

A chance shot into the crown of a forest giant growing near Point Camaron, San Blas, brought to the ground the one euphonia collected. No other birds of the species were seen.

140. **Piranga bidentata flamma**a** Ridgway. 

Tres Marias Tanager

Members of the *Ortolan* party, which visited the Tres Marias Islands in the spring of 1925, reported\(^4\) that tanagers were abundant on Maria Madre, but only one was seen in October. It was an adult male in greatly abraded plumage. Moult of the flight feathers has commenced, and many new feathers are present in the contour plumage.

141. **Cassiculus melanicterus** (Bonaparte). 

Mexican Cacique

This species was common about Labrados and San Blas. The noisy calls and brilliant plumage made it an especially striking feature in the avifauna of the region. At Labrados, Mexican Caciques were frequently found in company with Collie’s Jays, with which they form a commensal union.

Two males taken at Labrados September 23 and 24 are young birds acquiring winter plumage. A female collected at San Blas, October 10, is in similar garb. Two adult males taken at San Blas, October 3 and 12, have almost completed their feather renewal, although outer primaries and some of the rectrices are still in the sheath.

142. **Tangavius æneus æneus** (Wagler). Bronzed Cowbird

In waste areas in the vicinity of Mazatlan and Labrados, cowbirds were quite common. The collection includes three immature males, an adult and an immature female, and an immature unsexed bird taken at Labrados, September 20. The adult female is in greatly worn plumage, but moult is evident in the plumage of all the examples.

143. *Icterus spurius* (Linnaeus). Orchard Oriole

The chestnut and black plumage of adult males of this species was often in evidence in the wayside shrubbery about San Blas. No bird in this livery was noted at Labrados, but an immature male was collected there September 21. Two males taken at San Blas, October 2 and 8, are in fresh feather, but a third secured October 2 still has the outer three primaries, inner secondaries, many wing-coverts, and the rectrices in the sheath. A female taken on the same day is in a similar stage of feather development. The Labrados bird is experiencing a complete moult.

144. *Icterus pustulatus* (Wagler). Scarlet-headed Oriole

The harsh scolding note of the Scarlet-headed Oriole was frequently heard in the bush near the mainland collecting stations. At Labrados they seemed to associate themselves with the caciques. Four examples were taken at Labrados, September 22 and 23; and two more were obtained at San Blas, October 2 and 19. One immature female from Labrados shows only the first indications of moult. An adult male and an immature male and female have moult well advanced, but in the immature birds replacement of the rectrices has not yet commenced. The San Blas birds have assumed winter dress.

145. *Icterus graysonii* Cassin. Grayson’s Oriole

This bird was common on Maria Madre, where its scolding note called attention to its presence in the scrub growth on the eastern slope of the island. The immature male secured October 22 is undergoing moult, but the rectrices are not affected.


About the town of San Blas were numbers of ragged, tailless boat-tails, every stage of disreputable plumage being in evidence. The birds were in the patios and on the roof ridges, and appeared in the weedy wastes on the outskirts of town.
An immature and two adult males and an adult female were collected, October 5 and 10. A complete moult is in progress. A few faded feathers are in evidence and most of the fresh flight feathers are not fully developed.

147. **Megaquiscalus major graysoni** (Sclater).  
Grayson's Boat-tail

The waste area to the north of Mazatlan and the fields about Labrados generally held representatives of this form. An unsexed bird (adult male) and an immature male were obtained at Labrados, September 20 and 25. The moult of the adult bird is well begun, but none of the rectrices has been replaced. The immature bird has new feathers present on the forehead and breast, scapulars and interscapulars.

148. **Corvus mexicanus mexicanus** Gmelin\(^5\). Mexican Crow

Flocks of crows frequented the coconut grove to the east of the town of San Blas, and others were to be found about the mill site north of Blanca de Tierra Point. Two males and a female were collected October 5, 8, and 9. All examples are in fresh feather, the outer primaries in each case not being fully developed.

149. **Calocitta colliei** (Vigors). Collie's Magpie-Jay

This striking bird was frequently in evidence about Labrados in the company of the caciques. It was not present at San Blas, but on November 1, flocks were observed in the oak groves near Jalcocotan, Nayarit. An adult male and an adult and immature female were collected at Labrados, September 19 and 23. A complete moult is being experienced by the adult birds. The young bird is in its first contour plumage,

\(^5\) Meinertzhagen, Novitates Zoologicae, XXXIII, p. 87.
and, except for a new central rectrix, there is no indication of feather renewal.

150. **Cissilopha sanblasiana nelsoni** Bangs & Penard.  
San Blas Jay

Only a few of these jays were seen about San Blas, and they occupied the higher ground in the vicinity of the Tepic road. On October 15 and 16, two males and an unsexed bird were secured. The fall renewal of plumage is nearly complete in all specimens, only outer primaries and lateral rectrices not being fully developed.

151. **Cissilopha beecheii** (Vigors). Beechey’s Jay

Beechey’s Jays formed a very striking part of the landscape in the vicinage of Labrados. Their sociable habits and noisy calls render them very conspicuous as the flocks move from tree to tree, foraging as they go. An adult male and an adult and an immature female were obtained at Labrados, September 18, 22, and 23. The feather replacement of the adult birds is nearly complete, although some of the flight feathers are not fully developed. Renewal of the contour feathers of the immature female is in progress, but the flight feathers do not appear to be affected.
II

A CONTRIBUTION TO THE CLIMATOLOGY OF THE ICE AGE

BY

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It is impossible to escape the conviction that in the early history of the earth its surface was hot. It was at one time a molten mass. The mean surface temperature of the earth where land is exposed now ranges from about zero degrees at the poles to about 80° Fahr. at the equator. Under the ocean, that is on three-fourths of the earth’s surface, the temperature is about 35° to 40°. The mean temperature of the entire surface of the earth where not covered by water is generally given at about 55° to 60°.

On land areas there is a daily variation of ground temperature to a few feet in depth and an annual variation extending to depths of 20 to 50 feet, depending on the character of the composition of surface formations.

There is an increase in temperature with depth below the surface as shown by numerous temperature records in deep mines and in deep borings, as well as by the temperature of the water of deep flowing wells. This temperature increase, about 1° Fahr. in 40 to 60 feet, is of course quite variable, depending in large measure on the conductivity

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1 Address given as Retiring President of the Pacific Division of the American Association for the Advancement of Science, June, 1925.
of the geologic formations. Should it continue at the average rate as ascertained for the limited depths which have been explored, the temperature at 25 to 30 miles below the surface would be high enough to fuse most rocks. There is, however, some evidence that the rate of temperature increase below the surface decreases somewhat with depth. Though this is a generally accepted conclusion there is, nevertheless, no good reason apparent for assuming that increase of temperature with depth does not continue to 100 miles or more below the surface.

Be this as it may, there is no dispute as to the fact of great internal heat and that the present low temperature of the surface of this globe is the result of cooling. There was a gradual and we may assume fairly unbroken transition from the condition of great heat to a condition of temperatures as we know them today.

May we not, then, indulge in a little speculation as to what, while the earth was thus cooling, was the condition of the water which now rests in the ocean beds at an average temperature of some 30° to 40°. For a time, water could exist in the form of vapor only. A little later, when surface temperatures approached the critical temperature of water, some water fell to earth but was again converted into steam as soon as it fell.

If we imagine the water of the oceans distributed over the entire surface of the earth at a uniform depth, it would represent a layer with an average thickness of about 10,000 feet. Preceding the time when the temperature of the earth had fallen to the critical temperature of water, that is, the temperature at which water can no longer exist as a liquid (about 689° Fahr.) the atmospheric pressure was about 300 times as great as at present. A vapor blanket denser than water at its critical temperature enveloped the earth.

When the cooling of the crust of the earth had progressed to, or a little below, the critical temperature of water, the atmospheric pressure was about 200 times as great as we now know it. At less pressure, water could not have existed
as a liquid at this high temperature. One-third of the water was then liquid. Its density at that high temperature, 689° F. (365 C.) was only one-third as great as that of the water of our present ocean, consequently the one-third of the water which was liquid had a volume about equal to that of all the oceans of today, and the rest or two-thirds of the water was in the atmosphere as vapor. There was, moreover, no sudden change in the atmospheric pressure, while this change from dense vapor to water took place. Pressures everywhere remained the same during this transition because, in the depressions, hot water took the place of the hot vapor without change of volume. Thereafter, as cooling continued, more and more water was transferred from the atmosphere to the ocean and pressures on land areas became correspondingly less.

If all of the water could have been maintained in condensed form at its critical temperature of 689° Fahr., it would have covered the surface of the globe to an average depth of about 30,000 feet. On the assumption of the same inequalities in elevation of the earth’s surface as today, the ocean surface would have been 20,000 feet higher than now and only the peaks of a few mountain ranges would have been above water. But, as already stated, two-thirds of the water was necessary as vapor to establish the pressure at which water can maintain itself as a liquid at its critical temperature. There was therefore no time at which the ocean could have had this extreme extent.

As the cooling progressed to temperatures lower than the critical temperature of water, the proportional amount of water in the air as water vapor decreased as already stated, and the density of ocean water increased at such relative rates that, in all probability, there never was any very great departure in the actual volume of ocean water from that of today, once the critical point in the cooling process had been passed. For a long time during this cooling process, heat was fed from below into the superimposed water producing convection and keeping the oceans warm, not cold as they are today, and of course accelerating evaporation.
The climate was hot and humid due to the preponderance of earth heat. It could not be otherwise.

The presence of water has always interfered with distribution of heat over the surface of the earth according to any uniform law. This was true of the period during which earth heat predominated even as at the present time. Unequal distribution of heat in those early periods must have caused violent movements in the atmosphere and here and there condensation of moisture on a scale beyond compare with anything of which we conceive as having occurred in recent geologic times.

From the conditions under preponderance of earth heat to the atmospheric conditions as we know them today, I venture to assume a gradual uninterrupted transition, already suggested, of which the great extent of glaciers in the Ice Age was but a temporary local phenomenon.

However, as temperature thus dropped, a period must have been passed through in which ocean water approximated present day temperatures at its surface, though still receiving enough heat from the warm ocean bed to cause more or less convection. It is to be assumed that ocean currents resulted in this transition period which were incomparably swifter and deeper than those with which we are familiar, and that these currents had a pronounced effect upon local climate and on the distribution of rainfall.

Under this conception of gradual cooling there is no place for the sudden arrival of a temporary era of cold as so generally assumed by geologists. The many ingenious explanations of such an era of cold appear to be somewhat superfluous.

Wherever in the writings on the Ice Age we turn to find an explanation of the conditions which then obtained we find ourselves confronted with attempts to account for a period of cold followed by a warmer climate, conditions which have been assumed essential to explain, first the extension of ice fields and second, their retreat. The widespread conception applied to the Northern Hemisphere has been, and still is, that of a period of cold coming down
from the north followed by a moderation of climatic conditions with more sunshine, more rain and less snow, accompanied by a retreat of the ice northward.

Finding it necessary to offer some explanation for the assumed drop and subsequent rise in temperature of our northern latitudes, many have gone so far in this particular as to give serious consideration to cosmic causes such as suggested by Croll and ably discussed by numerous other geologists and physicists.

The precession of the equinoxes and secular changes in the eccentricity of the earth's orbit must, it is claimed, affect temperatures and may, therefore, account for the colder climate in the northern hemisphere during the Ice Age. It is claimed that in one-half of a cycle of 25,000 years, that is in 12,500 years from now we may expect another Ice Age. Our northern winters will be 22 days longer and 20 degrees colder, and our summers will be shorter, though much hotter than now. No one, however, who advances this cause of assumed, but not proved, recurrent ice ages, seems to have taken into account the obvious fact that a drop in the cold of winter in cold latitudes has little effect on the volume of accumulating snow, while a slight change in summer temperature has a relatively large effect on the rate of its melting and on the rate of evaporation; that, consequently, even less snow and ice is to be expected 12,500 years from now (in consequence of greater summer heat) when our northern summers and perihelion will occur at the same time, than at present with the earth in aphelion during our summer.

G. F. Becker (American Journal of Science, August, 1894) finds that in our temperate latitudes when the summer occurs at the time when the earth is at the point of its orbit nearest to the sun, the extreme summer temperature will be about 20° F. hotter than at present, and yet according to views frequently advanced, the longer colder winters are then to cause a great extension of glaciers.

In "The Age of the Earth" by Alphonse Berget (page 46) in discussing the exterior agencies which in the Quaternary
Era predominated in forming the earth’s crust, and in speaking of the enormous precipitation of rain in that era the author says: “Snowfalls, prevented from melting by the fall in temperature, caused an enormous extension of the glaciers, which at that time covered the whole of Central Europe and all of North America.”

The following is from a lecture by Professor Asa Gray delivered before Harvard University Natural History Society, April 18, 1878:

“North of our forest regions come the zones unwooded from the cold, the zone of arctic vegetation” . . . . “What would happen if a cold period were to come on from the north and were very slowly to carry the present arctic climate, or something like it, down far into the temperate zone? Why just what happened in the Glacial period, when the refrigeration somehow pushed all these plants before it down to Southern Europe, to Middle Asia, to the middle and southern part of the United States”; . . . . “Here then, we have reached a fair answer to the question how the same or similar species of our trees came to be dispersed over such widely separated continents. The lands all diverge from a polar center, and their proximate portions, however different from their present configuration and extent, and however changed at different times, were once the home of those trees, when they flourished in a temperate climate. The cold period which followed, and which doubtless came on in very slow degrees during ages of time, must long before its culmination have brought down to our latitudes, with the similar climate, the forest they possess now, or the ancestors of it.”

And again, in speaking of the Miocene Tertiary or later deposits, Professor Gray says: “Geologists give the same name to these beds in Greenland and Southern Europe, because they contain the remains of identical or very similar species of plants; and they used to regard them as of the same age on account of this identity. But in fact this identity is good evidence that they can not be synchronous. The beds in the lower latitudes must be later, and were
forming when Greenland probably had very nearly the same climate which it has now.” . . . “The Glacial period or refrigeration from the north, which at its inception forced the temperate flora into our latitude, at its culmination must have carried much or most of it quite beyond. To what extent displaced, and how far superseded by the vegetation which in our day borders the ice, or by ice itself, it is difficult to form more than general conjectures, so different and conflicting are the views of geologists upon the Glacial period. But upon any, or almost any, of these views it is safe to conclude that temperate vegetation, such as preceded the refrigeration, and has now again succeeded it, was either thrust out of northern Europe and the northern Atlantic States or was reduced to precarious existence and diminished forms. It also appears that, on our own continent, at least, a milder climate than the present, and a considerable submergence of land, transiently supervened at the north, to which the vegetation must have sensibly responded by a northward movement, from which it afterward receded.”

Geikie in his Text book of Geology says (page 887): “Under the name of the Glacial Period or Ice Age, a remarkable geological episode in the history of the northern hemisphere is denoted. The Crag deposits afford evidence of a gradual refrigeration of climate at the close of Tertiary ages.”

James D. Dana, discarding the effect of the changing eccentricity of the earth’s orbit upon climate as a cause of the Ice Age, nevertheless admits, apparently, that there must have been a general lowering of the temperature to permit the spread of the ice. On page 979 of his Manual of Geology we read: “the amount to which the mean temperature of the globe was lowered to bring on the conditions of the Glacial period was probably small . . . ” E. Brückner, in a recent discussion of the subject, concludes that a change in mean temperature of 8° F. to 10° F. would be sufficient.

Louis Figuier in “The World before the Deluge,” thus refers to the Ice Age: “The northern and central parts of
Europe, the vast countries which extend from Scandinavia to the Mediterranean and the Danube, were visited by a period of sudden and severe cold; the temperature of the polar regions seized them. The plains of Europe, but now ornamented by the luxurious vegetation developed by the heat of a burning climate . . . . became covered with a mantle of ice and snow.”

The Ice Age occurred at the close of the Tertiary and beginning of the Quaternary geologic period. This was at a time when the life on the earth was not greatly at variance with life of our time. But the earth’s surface was habitable, notably before the Ice Age, by animals and plants requiring a temperate or warm climate far to the northward of the points to which such climates now extend.

In the Tertiary Period there was a remarkable assemblage of animals on our continent, many species of which became extinct during the presence of the great ice sheet. Their remains are found in the post-Pliocene deposits. On this subject G. F. Wright in the “Ice Age in North America” says (page 387): “The program of events seems to have been about as follows: In the warm period preceding the Glacial epoch, when the vegetation of the temperate zone flourished about the North Pole, there was land connection between the continents, permitting the larger species of the Old World to migrate to North America. At the same time the conditions in North America were favorable to the tropical species of animals which had developed and flourished in South America. The refrigeration of the climate on the approach of the Glacial Period, and the advance of the ice from the north, cut off retreat to the Old World species and gradually hemmed them in over the southern portion of the continent, where all forms of life were compelled to readjust themselves to new conditions.” . . . .

“With the withdrawal of ice to the north, the struggle of these animals with the conditions of existence began anew, and the mammoth and some others found themselves unable to cope with the changes to which they were compelled to adjust themselves. From the abundance of the remains of
these animals found in the peat bogs of kettle holes in the glacial terraces of gravel and loess, it is evident that they followed close upon the retreating ice front, and some of them continued the retreat to the Arctic Circle, where they still live and flourish; while others like the elephant and mastodon, perished."

It should be added that the mammoth could live, under the mild climatic conditions of the Ice Age, so close to the margin of the ice, that occasionally one of them—probably in attempting to cross swamps at the sides or fringes of the glaciers—became entrapped and was conserved there in frozen condition even to the present day. Geologists tell us that many have been found with skin and hair and even the flesh well preserved. One such specimen of which there is record, was discovered in Northern Siberia at the mouth of the river Lena in 1806; another also in Northern Siberia in 1846 and another subsequent to the delivery of this paper in 1925 or 1926.

But it is not the purpose of this paper to discuss at length the general conditions on the surface of the earth during the Ice Age or the relative importance of changes in elevation of the glaciated regions and of changes in ocean currents which may have affected the extent of ice fields. Certain characteristics of the climate of the late Tertiary and Quaternary times, no doubt locally affected to some extent by the presence of the ice fields are, however, to be noted.

Let me now call attention to a feature of the Quaternary landscape which, like the glaciers has, due to a change in climate, disappeared. I refer to the Great Quaternary (or Pleistocene) lakes of the Lake Bonneville type. The largest of these, Lake Agassiz, owing to the fact that it was the ponded water at the southerly foot of the great North American ice field, should perhaps be put in a class by itself. But it, too, may be accepted as evidence of the fact that in its time there was abundant precipitation. The immediate concern will not be with this lake, however, but with the three, Lake Bonneville, Lake Lahontan and the ancient Lake Mono, all so well described by geologists of the U. S.

The birth of the Sierra Nevada may, according to the geologists, be placed in the Tertiary Period of Geologic time. Preceding the cataclysm which resulted in its upheaval there had been vast deposits over the entire western portion of our continent from ocean water or under ocean water and when the shrinkage of the earth's crust and its folding came these were lifted to high altitudes. Then erosion set in. River systems were formed on a large scale many of which were destroyed in a later era, when there was further shrinkage and more crumpling of the earth's crust, with much escape of lava, giving a new aspect to the country. The great depression between the Sierra Nevada and the Coast Range began to fill up with detrital material washed down from the mountains.

It was after the uplift of the Sierra Nevada in the late Tertiary and in the Quaternary epoch that the lakes already referred to had their greatest extent. The interior saucer-shaped basin or valley at the lowest point of which we now find the Great Salt Lake of Utah, was filled in the early part of Quaternary times with water to an elevation 1000 feet higher than the present lake level. This great ancient lake to which geologists have given the name "Bonneville" had an extent of 19,750 square miles. For thousands of years, long enough to clearly mark an easily traceable beach line, evidenced in places by large deposits of gravel, this lake had no outlet; then it broke its barrier to the north and discharged toward Snake River, cutting its outlet, with occasional pauses in its descent, down into soft rim-rock about 370 feet. Thereafter for other thousands of years it maintained a fairly constant level at the height of this outlet about 625 to 630 feet above the present lake level.

Another such interior Pleistocene lake covered a large area in Nevada now occupied in small part by Pyramid and Winnemucca lakes and by the sinks of Humboldt and Carson rivers. This lake is known as Lahontan Lake. Its extent was a little less than one-half of that of Lake Bonne-
Fig. 1. The Great Basin, United States.
Fig. 2. Lake Bonneville, Utah.
ville; its depth was nearly as great. Lake Lahontan had no outlet.

Ancient Mono Lake is the third of the Quaternary lakes, already referred to. This lake on the plateau at the eastern base of the Sierra Nevada had in Quaternary times a maximum surface extent of 316 square miles or four times that of the present Mono Lake. The surface of the ancient lake was about 680 feet above the present lake level. The ancient Mono Lake had no outlet. All of the water which fell upon the lake and upon the surrounding mountain slopes, as rain or snow, went back into the air by evaporation.

The physical facts of immediate interest relating to these Quaternary or Pleistocene lakes as taken from the reports of Dr. Gilbert and Mr. Russell in Monographs I and XI of the U. S. Geological Survey are as follow:

The greatest extent of Lake Bonneville was 19,750 square miles. Its highest stage was 1,000 feet above the present surface of the Great Salt Lake. Its drainage basin, coincident with that of the present lake, is 54,000 square miles in area. The outlet of the lake was at the north into the valley of Snake River. There was no outflow after the lake had fallen below the level of the Provo beach at about elevation 630 feet higher than the present lake. The area of the present lake is about 2,500 square miles. (See Fig. 2.)

The greatest extent of Lake Lahontan was 8422 square miles. The drainage basin in which this lake appeared has an area of about 40,000 square miles. The lake's average depth was about 500 feet. Its greatest depth 886 feet. (See Fig. 3.)

The greatest surface extent of ancient Lake Mono was 316 square miles. Its water surface was about 680 feet above that of the present lake. The present lake has a water area of about 85 square miles. Its drainage basin has an area of 973 square miles. (See Fig. 4.)

Of Lake Agassiz we are told by Warren Upham of the U. S. Geological Survey, that its surface extent was 110,000
Fig. 3. Lake Lahontan, Nevada.
square miles, its tributary watershed 350,000 to 500,000 square miles and its water surface elevation about 700 feet above the present surface of Lake Winnipeg.

The existence of these Pleistocene lakes, particularly of those which had no outlets, affords a convenient means for estimating the rainfall in their watersheds in the Quaternary epoch. The great extent of these lakes may be accepted as evidence that the rainfall was then far greater than in our day. It may be assumed that temperature did not differ greatly from the present, though somewhat warmer. The loss of water by evaporation from an open body of water from lakes and from the ocean was, therefore, probably materially greater in a given period of time than today. Assuming, however, for purposes of a first approximation that evaporation losses from the interior lakes was the same as at present, then by a simple calculation a determination can be made of the increased precipitation that would have been required to maintain the two land-locked lakes at their full stages.

This analysis indicates that the precipitation throughout the drainage basins of each of the two landlocked lakes must have been about twice as great, when they were at their greatest extent, as it now is. A similar calculation shows the same relation to present day rain, of the rainfall on Lake Bonneville when it had its greatest extent and before it broke its barrier to the north. After the outlet began to discharge Lake Bonneville water into Snake River, the rainfall may have been, relatively, still greater. There is no means of telling.

If the conjecture be correct that the weather was somewhat warmer in Quaternary times than now, then evaporation from the Quaternary lakes must have exceeded that of the present time and this excess, too, must have been made up by more rain. The assumption, therefore, that there was twice as much rain and snow in the plateau region of the continent in Quaternary times, than now falls there, does not seem unreasonable. It is probably an underestime.
Fig. 4. Ancient Mono Lake, California.
But if there was twice as much, or more, precipitation to the east of the Sierra Nevada, there must have been a similarly greater precipitation than at present on its crest and on its western slope. The normal precipitation throughout that portion of the Sierra Nevada which is known to have been covered with glacial ice—contemporaneously with the existence of the Quaternary lakes—now ranges from about 40 to above 90 inches per annum of rain equivalent. Most of the precipitation is in the form of snow. If this precipitation were doubled the annual snow fall at the high altitudes would exceed the annual depletion by melting and by evaporation and there would be an extension of glaciers down into the greater warmth of lower altitudes.

Exactly this occurred in Quaternary times. It will thus be seen that a warm climate of the period, conducive to the rapid transfer of moisture from the ocean to the atmosphere and back again to earth as rain or snow would account not alone for the large rivers and the great lakes of the plateau region but also for great local accumulations of ice in the concurrent Glacial Period, as in our own northern latitudes.

That, elsewhere, too, rainfall was heavy at this period of the earth’s geologic history is a well-known fact, thus for example L. Larter (in Comptes Rendus de l’Academie des Sciences in 1856) shows that the Dead Sea in late Tertiary or Quaternary times must have had a considerably greater extent than at present, as evidenced by sediments deposited over enormous stretches of country both to the north and south of the present lake. He correlates the existence of this ancient lake with the Glacial Epoch, evidences of which in this region are found in the moraines on Mount Lebanon. The ancient Dead Sea had a water surface about 1300 feet higher than the present lake.

It is worthy of note that evaporation rates have, heretofore, generally been over-estimated, and a few words, therefore, on this subject may not be out of place. The geologists of the U. S. Geological Survey have generally assumed an evaporation rate of 6 feet or more per annum in the plateau region. This is from two to three times greater than more
recent information on this subject would indicate. Numerous observations have shown that fairly close estimates of the yearly evaporation from open bodies of water can be made in regions whose mean monthly air temperature is known. Temperature is the dominant factor influencing the rate of evaporation. It follows that altitude, because temperature decreases with altitude, is to be taken into account when evaporation is to be approximated in regions where experimental observations are lacking. To illustrate—in temperate regions such as in the great valley of California, at sea level, evaporation from a large open body of water is about 4 feet per annum. At Lake Tahoe at an altitude a little over 6000 feet the rate is about 20 to 24 inches per annum. (Note. Evaporation from a pan floating in shoal, and therefore comparatively warm water on the western shore of the lake has been found by measurement to be about 30 inches. This is certainly in excess of actual evaporation from the entire lake surface). Using mean monthly temperatures at Truckee, and the evaporation rates indicated by the Kingsburg curve (See Trans. Am. Soc. C. E. Vol. LXXX, page 1978) evaporation in the Tahoe region at altitudes of about 6000 feet should be about 17 inches per annum.

At the Great Salt Lake, elevation 4200 feet, evaporation takes place at the average rate of about 30 inches per annum. The lake receives only a relatively small accession of water from July 1 to October 1. During this period of three months the average drop of the lake’s surface has been 1.2 feet in the 21 years, 1903 to 1923. In these three months the rainfall on the lake has averaged 1.3 inches. The accession of water to the lake from underground sources is known to be small. This is evidenced by the occasional large monthly drop of the water surface, due to unusual warm weather which allows no place for an assumption of material accession of water from underneath. The visible or surface inflow, during these months, is also very small. Allowing, however, a small amount for accessions of water other than by direct rainfall, the aggregate accession may be
called 2 inches or 0.17 feet. (This is equivalent to a continuous inflow of 133 sec. ft.) Evaporation during these three months must therefore have been about 1.37 ft. (1.20 + 0.17 = 1.37). But with the aid of mean monthly temperature records it is found that in the Salt Lake region the evaporation in the three months under consideration is about 60 per cent. of the annual evaporation. Consequently 2.3 feet, or 28 inches, is indicated as the average annual evaporation rate. It is preferred to call this about 30 inches or 2.5 feet, which as already stated, is less than one-half of the amount of evaporation per annum usually assigned by geologists to this plateau region.

There were great rivers in the epochs preceding and following the Ice Age and no doubt during the same. These were the result of large runoff caused by heavy precipitation. The shrinking of the glacier, extending, we must assume over thousands of years, contributed so little water to the runoff that this factor is negligible as affecting the stream flow of post glacial times. The annual melt and the shrinkage are not, in other words, to be confounded.

Preceding the filling of Lakes Bonneville and Lahontan and Mono Basin with water in Quaternary times, there appears to have been a period, generally referred to as a period of desiccation, during which cones of alluvial material were deposited at the mountain bases of the valleys. It is quite probable that this period was not as dry as might be supposed. The alluvial material required water for its transport but this water was evaporated probably under the influence of high earth and air temperature even as at so many other spots on the globe where the thick deposits of salt are mute evidence of the evaporation of vast bodies of water.

The great salt deposits as we know them in parts of the Old World, in central New York, and in the South, represent the evaporation of tremendous quantities of ocean water. Of those in New York State it is said that the quantity of water that must have been there evaporated was equivalent to a layer a mile in depth. Here, as in the case of the salt
deposits of Europe, there was probably a land-locked arm of the ocean full of water at a relatively high temperature, being evaporated, perhaps with earth heat, at a rate faster than freshwater flowed in from the surrounding drainage basin.

There is a constant flow into the Mediterranean Sea through the Straits of Gibraltar. Tributary rivers do not fully replenish evaporation losses. Its water therefore contains more salt than ocean water—about one-sixth more. In contrast with the Mediterranean Sea the waters of the Baltic Sea contain less salt than the ocean. The present-day accession of freshwater from tributary watersheds exceeds the evaporation. This condition was, as geologists tell us, less pronounced in an earlier geologic time. The water was then much saltier, quite likely due to greater evaporation resulting from warmth from underneath.

At many places on the globe a saturated brine was produced in land-locked bays and precipitation of the salt took place. How long it took to produce the known deposits which in New York State are 60 to 75 feet and which in parts of Europe as shown by deep borings, are 3000 feet and more in thickness, must be left to conjecture. The rate may have been rapid or very slow.

An extreme condition in the latter sense would be similar to that represented in our day by the Mediterranean Sea where nearly as much freshwater is annually delivered to the sea as evaporated from its surface with the result that its salinity is only slightly in excess of that of the ocean and apparently has changed but little through the centuries.

No better illustration than the world's great salt deposits is wanted of effects that have resulted from the hot condition of the earth's crust at the close of the Silurian age when these deposits were formed. At this time, moreover and in the epochs which followed, the climate was from temperate to torrid the world over, except only as modified by altitude.

When the cooling of the globe had progressed so far that in some places the winter precipitation was snow and not
rain, and this snow fell upon a land surface sufficiently cool, it began to accumulate. Despite the general warmth of the climate, which I venture to suggest must have continued throughout the Glacial period, the volume of snow which fell was in many places greater during the colder winter months than the heat of the following summer could melt. The snow began to pile up and the glacier began to form. Such a place on our own continent was the region between Montreal and Hudson Bay.

The southward advance of the North American ice sheet was not from the polar region. The ice accumulated at points of large snow precipitation and radiated from these points, notably from the point to the southwestward of Hudson Bay, in all directions. The ice flow and the extent of the glaciers must have been determined by the relation of the annual snow fall to the annual rate of snow melting. The glaciers continued to grow in extent in all directions and in thickness so long as the snow fall predominated; they commenced to shrink when there was more melting of the ice than snow replenishment.

The annual snow deposit at the beginning of the Glacial Epoch when the great North American glacier began to form slightly exceeded the rate of melting and evaporation, with the result that the ice fields which it formed were gradually extended toward the north, south, east and west until in due time the entire northern portion of the continent was an ice sheet with a greatest thickness of at least 10,000 feet and perhaps much more. Where this ice sheet covered the ground it was of course cold, particularly in winter, but speaking in a broad sense, the earth's climate all around the ice was temperate or warmer than temperate; this was the condition even in the Arctic region, toward which, as toward the south, there was a flow of the ice. This flow apparently emanated from the region where the ice field attained greatest thickness.

For any other satisfactory explanation of the accumulation of the ice than a generally warm climate with much rain and snow, we seek in vain. Many geologists, as already

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noted, assume that the earth passed through a period of low temperature and try to account for the same. And, then, in considering the obvious explanation, they are confused by the fact that glaciers existed in Cambrian and Permian times as well as in Quaternary. This should not be disturbing, because during all these periods much of the ocean, if not all of it, was warm and evaporation was large with consequent heavy precipitation and with large stream-flow in some places and large accumulation of snow in others. It would take but slight changes in the direction of ocean currents and in elevation, many of which are known to have occurred, to change the places of heaviest precipitation and even to produce an ice field where, without change of general climate there had been none before.

Broadly speaking, the period of heavy but gradually decreasing rainfall must have continued until the ocean had cooled to near its present temperature. The decrease of precipitation considered in the aggregate over the entire surface of the globe, though gradually approaching that of our day, was still sufficient in Quaternary times to supply water to great river systems, and to supply more snow to vast continental areas than rains and solar energy could reduce to water. It was later, perhaps, that the effect of earth heat upon the rate of evaporation became negligible as a factor and the fall of rain and snow was correspondingly reduced. The melting of ice began to exceed replenishment by snowfall, and the shrinking of the ice field commenced. This shrinking did not, as already stated, cause the great post glacial floods of which there is abundant evidence. Melting was a slow process even as the forming of the glaciers had been slow. It is, moreover, a process going on even in our own day to a measurable extent without notable effect on the flood-flow of glacial streams. The retreat of the glaciers of Switzerland is an historic fact, as also that of the glaciers of Alaska. They will never again advance unless, indeed, there be such shifting of ocean currents and of storm tracks or changes in altitude as will materially affect local precipitation to the advantage of the glacier.
According to the conception of the Ice Age as occurring during a period when the climate was warm, during a period when the earth’s temperature at the poles was still sufficiently high to maintain conditions as we now know them in temperate or semi-tropical zones, the Ice Age most probably fell into that period of geologic time in which the influence of earth temperature upon the temperature of the ocean was dwindling. It is because of this fact, if it be a fact, that no recurrence of the Ice Age is to be looked for. The advance of the ice, its retreat and readvance all fell into one geologic epoch, controlled by terrestrial influences as already suggested.

From the exhaustive studies of the late Dr. G. K. Gilbert, we learn with reference to Lake Bonneville that before the great flooding, the water-level was low and that this pre-Bonneville period was of great duration compared with those that have followed. A first Bonneville high-water appears to have been followed by a period of near or complete desiccation. Then came a second period of high water, the waters rising until overflow was reached. Subsidence followed down to the level of the Provo Beach, 370 feet below the highest lake stage and there, there was a long halt. Then came the further recession to the existing condition.

Geologist Russell finds evidence in the Mono Lake basin to substantiate Dr. Gilbert’s conclusion that these Quaternary lakes had two successive high stages, a fact which, if accepted, would be in substantiation of the claim that there were at least two successive advances of the ice sheet; that there was a fairly long interglacial period.

Concerning such an interglacial period, W. B. Wright in his Quaternary Ice Age (p. 171) remarks that “Opinion is by no means undivided as to the interglacial significance of these beds” (the Toronto formation). “It is generally admitted that they must have been formed during a temporary retreat of the ice from the immediate neighborhood of the sections, but there is the usual disagreement as to the extent of the retreat.”
Referring to the same Toronto Formation, Mr. G. W. Lampaugh in an address in 1906 before the Geological Section of the British Association, said: "On this and other evidence it is clear that during the course of the Glacial period the whole of the district was for a considerable time released from the ice sheets which previously and afterwards covered it. Moreover, in the opinion of Professor Coleman" (A. P. Coleman who first described the interglacial Toronto Formation), "Some of the plants and shells of the warm climate beds denote conditions which would be incompatible with the persistence of the ice sheets anywhere in Canada; and if this be so, then we here have proof for at least one interglacial epoch. But I still permit myself to feel doubt regarding this last mentioned deduction, as the shells and plants in question, which have their present habitat in the Middle United States, even yet endure winters of considerable severity; and there are certain factors in the composition of the beds and their altitude above Lake Ontario that justify caution."

G. F. Wright in "The Ice Age of North America," sets forth reasons for regarding the period as a unity but he says (page 195): "On any view of the case we are compelled to regard the Glacial period as one of great vicissitudes. Evidently . . . there were great irregularities both in the advance and in the retreat of the ice. From a combination of causes which can not yet be explained there were periods of rapid advance alternating with periods of retreat, intercalated with long periods of equilibrium. The glacialist possesses the great advantage of having a most complicated cause at hand to account for his phenomena. But while this enables him to explain everything, it as well prevents him from being over-confident in any special solution he may present of minute problems."

Not only does it appear that the rainfall and snowfall in Quaternary times must have been twice that of the present time, or more, but our Pleistocene lakes have left good evidences to show which way the wind blew.

A recent visit to the Point of the Mountain (See Plate 1),
some 30 miles south of Salt Lake City and an inspection of the Bonneville Beach gravel deposit at that point led to some speculation as to how this large deposit was made. It is not a detrital alluvial cone in the ordinary sense. There is no break in the mountain range through which the gravel could have been brought by a creek or river into the main valley. The gravel must have been moved along shore until it found its resting place. Water actuated by wind was the transportation agency. It appears clear that while Lake Bonneville stood for thousands of years at the level marked by this beach formation, the prevailing winds were not unlike those of today. The summer winds were from the north or slightly northwest, the winter brought the strong blows from the south.

Each ravine descending from the bordering mountain range contributed some gravel to that formed by wave action at the base of the ancient sea cliffs. On this long extent of north and south beach to the northward of the Point of the Mountain this gravel was shifted about by wave action. The direction of the beach was slightly south of west turning at a pronounced spur, against which the great gravel spit now rests, abruptly to a southeasterly direction. The waves driven by the northerly wind during the summer months picked up the surface layer of gravel particles and rolled them obliquely up the beach in a southerly or southeasterly direction and under the influence of the return flow of the water which was left on the beach by each succeeding wave they then rolled down again, but in a direction normal to the direction of the beach. Each such displacement took them a little further south on the beach, a little closer to the Point of the Mountain. At this point the waves from the north, running there at right angles to the shore line, lost their power to transport the gravel lengthwise of the beach and the gravel came to rest. Not only was this the case but the winds from the south which in winter sent waves against the shore southward from the Point of the Mountain caused a similar creep of shore gravels toward the north, and their influence in this
direction, too, stopped at this point. No other causes were needed to accomplish the building of the gravel spit.

Referring to a similar deposit of gravel on the same old Bonneville Lake shore at the pass between the Tooele and Rust valleys, where a spit of gravel projects westerly having a length of about 7000 feet and a height at its extremity of 150 feet, Dr. Gilbert says: "The greatest waves came from the north, and beating on the southeast shore of Tooele Bay, carved out a long line of sea cliffs." Dr. Gilbert speaks of the waves and undertow and a littoral current as the agencies which contributed to a southward transport of the resulting gravel. The assumption of the littoral current is superfluous, it probably did not exist, certainly not of force sufficient to transport gravel. At lower stages of the lake still more gravel was added to this great gravel bar, usually referred to as the Great Bar near Stockton. Here as at the Point of the Mountain, there is clear evidence of persistent strong winds from the north—no doubt the spring and summer winds and of wind, too, from the south—the winter winds.

All the available evidence appears to indicate that during the Glacial Age the climate in general and particularly in the polar regions was similar to that at present in the temperate zones. There were, no doubt, at that time certain regions in which earth heat still had a strong effect on surface temperature and particularly upon the temperature of ocean water. Such a point of influence may have existed in the North Pacific, where even today our storms appear to originate and possibly, too, in the North Atlantic. Accelerated evaporation, due to earth heat and relatively high temperature, loaded the air with the vapors which fall as snow in the north of Europe and which in the north of our own continent produced the glaciers.

It is quite conceivable that as cooling progressed and evaporation decreased, both the continental ice sheets and the Quaternary lakes began to shrink, in each case due to lack of snow and rain, and that later activity of the plastic mass under the crust of the earth resulted in a belated local
rewarming of ocean waters and of a second period of heavy precipitation with partial restoration of the ice sheet and a complete refilling of the Quaternary lakes.

Though he doubts somewhat the importance of precipitation as a factor controlling the extent of ice fields, some light is thrown on this subject by W. B. Wright of the Geological Survey of Ireland in his work on "The Quaternary Ice Age." He says (page 450): "There has of recent years, been a tendency among geologists to exaggerate the importance of precipitation in the production of glaciers and ice sheets" . . . . "The really essential thing" he says "is the lowering of the snow line so as to bring some portion of the range into the region of perpetual snow." But he continues: "This nevertheless does not make the matter perfectly clear, for the height of the snow line, although mainly a matter of temperature is to a certain extent, dependent on precipitation. Thus, in the west of the Alps, and in the extreme southeast, near the Adriatic, where the precipitation is greatest, the present snow line is relatively depressed."

Again quoting Dr. Gilbert: "To account for the origin of Bonneville Lake, we need to assume a climatal change that would increase precipitation or diminish evaporation; and both of these effects would follow, in accordance with familiar meteorological laws if the humidity of the air were increased, or if the temperature were lowered."

Dr. Gilbert seems, however, to have failed to consider the possibility of increased precipitation outweighing the local effect of increased evaporation that would take place under the influence of a warmer climate.

Several facts may be cited to show occasional long time persistence of weather types. Thus, for example, some 60 years ago, Goose Lake in the extreme northeastern portion of California, extending over the boundary line into Oregon, contained enough water to overflow. The rainfall since that time, however, has not been sufficient to offset the evaporation from the lake and it has been shrinking. The same is true, though less obviously in the case of Tulare Lake whose bed has repeatedly been dry since 1898 but
which had been overflowing from 1862 to 1876. In the case of Tulare Lake it is known that at some remote date, historically and not geologically speaking, the lake had been very low—far below the overflow level, almost desiccated in fact, for a period long enough to permit willow trees to take root some 17 feet below the lake’s high water level and grow to diameters of 4 feet and more. These facts show the occasional persistence of comparatively light rainfall for long time periods, for half centuries and possibly for centuries, followed by other long periods with more precipitation. In the case of the Great Salt Lake similar variations in the amount of precipitation for series of years is to be noted. This is clearly evidenced by the known fluctuations of lake levels. This lake was low in the 40’s, continuing so until about 1860. It then rose from year to year to a stage about 10 feet higher culminating in 1870 and holding the high stage for seven or eight years. There was thereupon a drop to a second low stage in the 90’s at which time the consensus of opinion seems to have been that the lake would feel the effect of diversions of water from its tributary rivers for irrigation and would never again rise to a high stage. The lake, however, responding to the effect of somewhat larger precipitation began to rise again and has now for several years been at or near the high stage of 50 years ago. No regularity of any kind is indicated for the alternative periods of lows and highs—of persistent light rainfall and of persistent heavier rainfall.

Bearing on this matter and to show that causes for local changes in climate are not difficult to find, Prof. C. H. Hitchcock might be cited as shown by the following taken from Warren Upham’s Monograph on “The Glacial Lake Agassiz”: “The general absence of Pliocene formations along both the Atlantic and Pacific Coasts of North America indicates, as pointed out by Prof. C. H. Hitchcock, that during this long period all of the continent north of the Gulf of Mexico held a greater altitude, which from the evidence of these submarine valleys is known to have culminated in an elevation at least 3000 feet higher than that
of the present time. Such plateau-like uplift of the continent appears to have exerted so great influence on its meteorological conditions, bringing a cooler climate throughout the year, that it finally became enveloped by ice sheets."

... "The thickness of the ice in the region of the White Mountains and Adirondacks was about 1 mile; and Dana has shown from the directions of striations and transportation of drift that its central portion over the Laurentide highlands between Montreal and Hudson Bay had, probably, a thickness of fully 2 miles."

In discussing climates, as already stated, we are too apt to compare mean annual temperatures with each other, regardless of variation in extremes, forgetting that a difference of a few degrees in the warmer months of summer counts for very much more than the same difference in winter months at a temperature below the freezing point. Thus, for example, in the matter of temperature influence on evaporation: When the mean monthly temperature is below the freezing point the evaporation from open water, or from snow and ice surfaces, is very light. Consequently no drop in temperature even to many degrees below zero of our Fahrenheit scale can affect the amount of evaporation in any given time to any great extent. Changes of 20° or even of 40° in the mean monthly temperature of the winter months of our northern latitudes would affect the aggregate annual evaporation but little. On the other hand a change of a single degree Fahr. in the mean temperature of a single month will add to the monthly evaporation from 0.1 inch to 0.3 inch according to whether the mean monthly temperature is in the neighborhood of 40° or in the neighborhood of 80°. In its influence on meteorological conditions, and especially on evaporation a few degrees of change in the mean temperature of summer months, then, will outweigh the influence of any possible change in mean monthly temperature of winter months particularly if the winter temperatures are below the freezing point. Where winters are cold the mean annual temperatures are, therefore, of but little moment in a discussion of the weather conditions which
affect the persistence of ice or of land-locked bodies of water throughout a series of years. It is the temperature of the warmer months of the year which counts. If a summer month has a temperature 10° in excess of a normal of 70° the evaporation during such an unusually hot month will exceed normal evaporation by nearly 3 inches. (Evaporation from a large open body of water is here meant—not evaporation from experimental pans, in which there is always an accelerated rate.) And if such a departure of temperature from normal should persist throughout an entire summer season the consequent departure of evaporation from normal in the year might easily reach 10 to 20 inches of excess, even though the departure of temperature in summer be offset many times over by excessive cold in the winter months.

In our temperate latitude, departure from the mean monthly temperature in the amount of 10° is not common nor is such a departure likely to extend to all the warm months of any single season. But when we go back in geologic time to an earlier period, to a period even as recent as the Quaternary, it takes no great stretch of the imagination to conceive of a climate a few degrees warmer in summer than that of our time. It must have been so, if there is any merit in our conception of the gradual cooling of our globe.

The greater warmth sent greater volumes of water into the air from wet ground, lakes and oceans and, as all of the water rising as vapor must fall to earth again, there was a corresponding increase of aggregate precipitation. It is readily conceivable that there was sufficient concentration of this excess, on our Sierra Nevada and east thereof and, too, in the region of the great ice fields of the north to maintain our local Sierra Nevada glaciers and the Pleistocene lakes, and the great glaciers of the Ice Age.

The climate of the Ice Age was, then, characterized by greater warmth and not by greater cold than in our day. This, of course, does not mean that the presence of the ice and the heat consumed in its melting did not have some
local effect upon temperature of the atmosphere and, therefore, upon climate.

Evaporation from ice and snow is relatively very light. The melting of the glacial ice, too, is slow at the low temperatures which prevail in a region of glaciers. Furthermore, the greater differential in heat content of the air over the warm ocean and over a great adjacent ice field must have been conducive to cloudiness and consequently a shielding of the ice field from the direct rays of the sun. The ice may be conceived as having caused local low temperatures, rather than that cold was the cause of the Ice Age.

High ocean temperature and disposition of land and water favorable to heavy precipitation in the northern hemisphere together with some changes in altitude1, probably quite moderate, and a somewhat warmer climate, would appear sufficient to explain the Ice Age. Lower mean temperature of the globe than at present could not have existed, though temperatures may have been lower in some localities. A generally cold climate with lesser evaporation and consequent lesser precipitation would not necessarily result in the growth of glaciers. Heat with large evaporation, and heavy precipitation will fully account for the vast accumulations of snow and ice in favored localities. The Ice Age fell, we may assume into that period at which the earth's crust had cooled to near present day temperatures but during which the ocean was still receiving heat from below, in spots at least, causing convection and probably ocean currents much more pronounced than those of our day in which ocean water is warmed to a slight depth only by the heat from the sun.

The two great centers of atmospheric depression, the regions in which the great cyclones originate, which bring rain, are near Greenland and near the Aleutian Islands.

1Changes in altitude were caused, in large part, no doubt, by the gradual shifting of the vapor load from the land areas to the ocean during the time that the temperature at surface of the Earth dropped from the critical temperature of water (365° C) down to that of the present time. A great load was thus removed from the land areas, as the vapor condensed and flowed into the ocean. On the basis of the relative extent of land and water areas the shifting of the water load must have been equivalent to a removal of about 6000 feet in depth of water from land areas and the addition of about 2000 feet in depth to the ocean.
On the assumption that these same centers of barometric lows existed in the Ice Age and that the paths of the storms were substantially the same as today but that storms were of greater extent and dropped more rain and snow, the localization of the great ice sheets in the northern part of our own continent and in the northwestern part of the Eastern continent could be fully explained. There were no glaciers in northern Asia because the air had lost its surcharge of moisture before it got that far.

Some geologists are not satisfied with a single interglacial epoch but contend for a number of such epochs—up to six or perhaps even more. Changes in the distribution of rainfall due to local causes such as modifications of ocean currents or the formation of new mountain ranges, would amply account for such breaks in the continuity of the Ice Age.

Because changing extent of land areas and moderate changes in elevation will readily account for local variations in the amount of snowfall there must have been many places in past geologic times where conditions were favorable to the formation of glaciers. Some evidence of glacial action is, therefore, to be expected far back in geologic history. The glacier, in other words, resulted from the same general prime cause as the great river systems of the past. It is only, however, in such places as the Dead Sea and as in our own Quaternary Lakes that we note a clear correlation of ample water production and its accumulation in land-locked basins, with the presence of glaciers.

Russell reaches the definite conclusion that the greatest expansion of Lakes Mono, Lahontan and Bonneville was contemporaneous with the maximum extension of the North American ice sheet. He says “The last great expansion of the lakes of the Great Basin occurred during the close of the Glacial period, and may be considered as contemporaneous with the Champlain epoch of the Eastern States.”

The interglacial epochs whether one only, or a number, as contended for by many geologists, are almost invariably referred to as periods of warmth. This conception is reasonable but implies a conception of the Ice Age as a period of
cold. I venture to believe that, except as locally modified by the presence of ice, the entire Ice Age together with its interglacial period was a period of warmth, a period of large evaporation from open bodies of water and in consequence a period of heavy precipitation making for large stream flow and for large snow fields.

I have ventured in the foregoing to question the generally accepted conception of the earth having passed through any period of cold. I have pointed out that the land-locked Pleistocene lakes, Ancient Mono, Lahontan and Bonneville, afford means of approximating precipitation in relation to that of today; that this precipitation was probably twice as great; that heat with consequent large evaporation was necessary to produce this heavy precipitation, and that because the existence of these lakes was contemporaneous with the Ice Age, the accumulation of snow must also have been due to heavy precipitation. The climate of the Ice Age, generally speaking, must therefore have been warm, warmth being necessary to account for heavy precipitation. Diversity of climate then, as now, is clearly indicated by the records as they have been interpreted by geologists although in this and earlier geologic times the influence of latitude, owing to more widely distributed earth heat, was probably somewhat less than now.

Periodic changes in the extent of the ice fields and of the Pleistocene Lakes can be fully accounted for by changes occurring from time to time in continental outlines and elevation of landmasses with resultant changes in ocean currents. There is then no need of assuming an era of cold as the cause of the Ice Age. Where the climate was locally colder than it now is, the presence of the ice was the cause and not the result of the cold.
Fig. 5. View near Point of the Mountain and near Salt Lake and Utah County line, from Redwood Road looking S. E. toward Timpanogus, seen in the background, capped with snow.

Fig. 6. View near Ogden, Utah.
III

THE MARINE MIOCENE DEPOSITS OF NORTH COLOMBIA

BY

FRANK M. ANDERSON

This paper is offered as a preliminary note on the Miocene section of northern Colombia, concerning which a more complete discussion will be furnished later. The section is the somewhat incomplete series occurring near Puerto Colombia at Tubera Mountain, Usiacuri, and neighboring points.

Its aggregate thickness at Tubera Mountain is near 2800 feet, which has been divided into a number of horizons, or stages, some of which are fossiliferous. In the following tabular outline they are designated by letter:

<table>
<thead>
<tr>
<th>Letter</th>
<th>Description</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>Top of section, not locally represented</td>
<td>2,650</td>
</tr>
<tr>
<td>S</td>
<td>Soft, medium-grained sandstone at the top of Tubera Mountain</td>
<td>450</td>
</tr>
<tr>
<td>R</td>
<td>Soft yellowish sandstone at Tubera village, containing numerous fossil Mollusca</td>
<td>350</td>
</tr>
<tr>
<td>O</td>
<td>- Sandstones and shales, northwestern slope of Tubera Mountain</td>
<td>400</td>
</tr>
<tr>
<td>Q</td>
<td>- Sandy shales and soft incoherent sandstone with feruginous layers</td>
<td>400</td>
</tr>
<tr>
<td>P</td>
<td>- Gravelly sandstone, hard in part, with species of Turritella, Spondylus, and other forms</td>
<td>550</td>
</tr>
<tr>
<td>M</td>
<td>- Blue or gray shales, soft shaly sandstone, and pebbly beds, conglomerate, etc</td>
<td>250</td>
</tr>
</tbody>
</table>

Total, 2800 feet
The most fossiliferous stage is "M", of which a brief account will be given here on account of its special position and faunal character.

Beneath "Stage M" there are clay shales, sandy shales and hard cherty beds occurring near Las Perdices and other points, the thickness of which is not known beyond a few hundred feet. It contains a few species of Mollusca, bone fragments and scales of fishes, sponge spicules and numerous species of Foraminifera.

Dr. G. Dallas Hanna has made a preliminary examination of these shales and has offered the following notes:

"The shales contain a very considerable number of fossils, the groups being represented about as follows in order of abundance: (1) Radiolaria; (2) Diatomaceae; (3) Foraminifera; (4) Sponges; other organisms are scarce. There has been pyritization to a considerable extent and many of the chambers of the fossils are filled with iron sulphide. A great many of the diatoms have been replaced entirely and internal casts of the frustules are abundant. Coscinodiscus was the only genus definitely identified in this group. Many of the genera and some of the species of Radiolaria are the same as have been found in the famous deposit on Barbados Island and which Payne has put definitely in the Miocene. Some of the genera are: Stylodictya, Histiastrum, Stylophæra and Eucyrtidium. Foraminifera are scattered rather sparingly through the mass of the material, the common genera being: Globigerina, Orbulina, Lagena, Truncatulina, Cassidulina, Nodosaria, Anomalina, Frondicularia, Plectofrondicularia and Bolovina. It is believed that these organisms offer a means whereby a definite correlation can be made with strata of known age elsewhere. This preliminary examination indicates that the formation lies very close to the base of the Miocene, if, in fact, it is not the lowermost part of the sediments of that period."

"Stage M" is in part a coarse pebbly sandstone, often forming conglomerate near the base, and quite fossiliferous, including many heavy-shelled species and littoral forms not found higher up in the section. Some of the slaty pebbles at the base have been perforated by boring molluscan species, which fact, taken together with the character of the fauna itself, shows this horizon to have been deposited near shore, and the character of the pebbles indicates that the shore formations were such as have been described for underlying rocks.

From the foregoing statements it would appear that "Stage M" rests unconformably upon these formations, but as to whether the latter group may not also be a part of the Miocene series has not hitherto been known. "Stage M" is believed to be older than any other similar group of the Miocene in Colombia, and since it is found at Punta Pua east of Cartagena, and at other places still more distant, its occurrence is not local, and its fauna is characteristically littoral, as already stated.

This stage is undoubtedly older than the Gatun group as found at the spillway of the Canal, though probably not older than some of the beds placed in the Gatun group by other writers. In Costa Rica Olsson has described Miocene beds thought to belong to the Gatun group, but older than those occurring near Gatun. They may be contemporaneous with "Stage M" of the Colombian section, and if so, both should also be correlated with the Cercado stage of Santo Domingo (Maury), which is probably older than the Gatun group of the Canal Zone.

Some of the more characteristic species from "Stage M" are included in the following list:

<table>
<thead>
<tr>
<th>Species</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antigona caribbeana n. sp.</td>
<td>Cypraea henekeni Sowerby</td>
</tr>
<tr>
<td>Arca veatchi Olsson</td>
<td>Conus molis Brown &amp; Pilsbry</td>
</tr>
<tr>
<td>Arca rel. chiriquiens Gabb</td>
<td>Architectonica gatunensis Toula</td>
</tr>
<tr>
<td>Arca (Scapharca) auriculata Lam.</td>
<td>Natica cuspidata Guppy</td>
</tr>
<tr>
<td>Cardium (Trachycard.) lingualoens Guppy</td>
<td>Natica guppyana Toula</td>
</tr>
<tr>
<td>Cardium (Laecivard.) dalli Toula</td>
<td>Mitra henekeni Sowerby</td>
</tr>
<tr>
<td>Glycymeris jamaiicensis Dall</td>
<td>Strombus puigoloides Guppy</td>
</tr>
<tr>
<td>Glycymeris lloydsmithi Brown &amp; Pilsbry</td>
<td>Strombus gatunensis Toula</td>
</tr>
<tr>
<td>Mactrella (Harvella) elegans Sow.</td>
<td>Terebra rel. haitensis Dall</td>
</tr>
<tr>
<td>Pitaria cercadica Maury</td>
<td>Terebra bipartita Sowerby</td>
</tr>
<tr>
<td>Raeta gibosa Gabb</td>
<td>Terebra gatunensis Toula</td>
</tr>
<tr>
<td>Spondylus bostrychites Guppy</td>
<td>³Turritella abrupta (Spieler)</td>
</tr>
<tr>
<td>Spondylus cf. gumanomocon</td>
<td>Turritella altilirata Conrad</td>
</tr>
<tr>
<td>Brown &amp; Pilsbry</td>
<td>Turritella planigyrata Guppy</td>
</tr>
<tr>
<td>Venericardia brassica (Maury)</td>
<td>Petaloconchus domingensis Sowerby</td>
</tr>
<tr>
<td></td>
<td>Serpulorbis papulosa Guppy</td>
</tr>
<tr>
<td></td>
<td>Carcharodon cf. rectus Agassiz</td>
</tr>
</tbody>
</table>

³Spieler has described as a variety of T. robusta Grzy, a form which he calls var. abrupta from the Zorritos formation of Peru. (See Johns Hopkins University Studies in Geology, No. 3, 1922, p. 85, Pl. IV, fig. 6.) The Colombian species is probably identical with this, which can be distinguished from T. robusta Grzy., not Gabb (=T. supraconcava Hanna & Israelsky, 1925).
The description of only a single species thus far found in "Stage M" can be offered to illustrate its fauna at the present time, though its full stratigraphic range is not yet known.

**Antigona caribbeana** Anderson, new species

*Antigona multicolorata* Olsson (not Sowerby), Bull. Am. Pal. Vol. IX, p. 411, Pl. 30, fig. 1; Gatun stage, Water Cay; Lower Miocene of Costa Rica.

This immense species of Antigona is perhaps the largest representative of the genus yet found in the Caribbean Tertiary deposits. The holotype here figured measures 6.75 inches in length, 6.25 inches in altitude, 4.75 inches in entire thickness; weight of a nearly complete well-cleaned shell, 4.6 pounds. Shell cordate in outline, when full grown, though younger individuals in the collection are somewhat quadrate, as shown in Olsson's figure; umbones prominent, though depressed, drooping forward; dorsal margin roundly curved from beak to posterior end in the holotype, though younger shells somewhat angulated at the rear; anterior dorsal margin narrowly rounded; ventral margin nearly circular, or a little straightened behind; lunule relatively small, impressed, bordered by a sharp groove, flattened though rugose throughout by concentric lines of growth; escutcheon deep and wide, bordered by a pronounced ridge, from which, on the left valve, the slope is much broadened, overlapped only at the rear; ligamental groove deep and wide; hinge plate short, as shown in the figure, and relatively heavy as compared with its near relative, *Antigona multicolorata* (Sowerby); inner margin of the shell finely crenulated, in which respect it differs from the latter species; muscle scars large, anterior deeply impressed; surface of shell concentrically costate with about 46 strong but almost smooth, flattened concentric ridges, slightly nodose on the anterior end of the shell.

*Type:* No. 2521, Mus. Calif. Acad. Sci. from Tubera Mountain near Puerto Colombia, Colombia; Miocene.

This species is doubtless a near relative of the smaller living and Pleistocene form described by Sowerby as *Venus multi-*
*costata* from the Panama region,\(^4\) which has not yet been shown to occur in the Miocene deposits. Possibly another near relative is found in the smaller *Venus ducatelli* Conrad from the Miocene of Maryland. Our species differs from the living *V. multicostata* in being larger, and relatively heavier, with shorter and heavier hinge plate and teeth, and in being ornamented on the surface by smoother, less nodose concentric costae, and within by crenulations along the ventral margin of the shell, which the living species lacks. It differs from *V. ducatelli* in being much larger and heavier, with more prominent umbones, relatively heavier hinge, and crenulated interior margin.

Plate 2

Antigona caribbeana Anderson, new species. Type No. 2521 (Mus. Calif. Acad. Sci.) from Tubera Mountain, near Puerto Colombia, Colombia; natural size.
Plate 3

*Antigona caribbeana* Anderson, new species. Type No. 2521 (Mus. Calif Acad. Sci.) from Tubera Mountain, near Puerto Colombia, Colombia; natural size.
IV

FISHES FROM EASTERN CHINA, WITH DESCRIPTIONS OF NEW SPECIES

BY

BARTON WARREN EVERMANN

AND

TSEN-HWANG SHAW

This paper is a report on two small collections of Chinese fishes, the first made by the junior author at Shanghai, Woosung (near Shanghai), Nanking, Hangchow, Sunkiang, and Chuchi, in 1924-1925; the other by Professor Chi Ping of Southeastern University, Nanking, China, at Chefoo, Nankiang, Woosung, Ningpo, and Wenchow, in 1921 and 1922. The specimens collected by Professor Ping were kindly sent by him to the senior author for identification and report. The collection made by Mr. Shaw was brought by him to America in 1925 and presented by him to the California Academy of Sciences.

The total number of specimens examined is 128, of which 94 were collected by Mr. Shaw and 34 by Professor Ping.

The localities and the number of specimens from each is as follows:

January 31, 1927
A series of duplicate specimens has been sent to Doctor Ping at Nanking.

The writers are under obligations to Mr. H. Walton Clark for valuable assistance in the study of these specimens.

Type localities are printed in black-face type.

Family Carcharhinidae

1. Scoliodon laticaudus (Müller & Henle)
   Chinese name, Sar-yu (Sand-fish)

   One specimen (No. 875), a young individual 274 mm. long from tip of snout to end of caudal fin, collected by Dr. Ping at Wenchow, Chekiang.

   Body compressed; head depressed; snout long. Head 3.2 in length of body without caudal; depth 6.5; eye with nictitating membrane; first dorsal without spine, opposite space between pectoral and ventrals; second dorsal behind origin of anal; length of anal nearly equal to its distance from ventrals; pectoral not reaching origin of first dorsal; caudal 8.7 in total length with tail, with a distinct lower lobe; length of preoral portion of snout exceeding width of mouth; a short labial groove at angle of mouth, not extending on upper jaw; teeth in both jaws, none serrated; a small pit above root of tail; mouth crescentic, inferior. Color dark brown.

   Carcarias (Scoliodon) laticaudus Müller & Henle, Wiegmann's Archiv f. Naturg., 1837, I, 397, East Indies.
2. Hemigaleus pingi Evermann & Shaw, new species

One specimen. Body elongate, slender; head depressed, flattened below; spiracle small; nictitating membrane present; mouth with distinct labial folds; first dorsal opposite space between pectoral and ventrals; length of preoral portion of snout equals width of mouth; distance between eye and spiracle about 3 in diameter of eye; mouth inferior, crescentic, the groove at angle extending some distance on each jaw; nostrils nearer mouth than to snout; distance between outer point of nostrils slightly greater than width of mouth; three rows of teeth on upper and lower jaws, each tooth with a basal lobe; pectoral near gill-opening; second dorsal a little in advance of anal; a pit below and one above caudal. Color dark brown, lighter below; a few black spots on each side of body.

Type: No. 500, Mus. Calif. Acad. Sci., a specimen (original No. 851), 266 mm. long, collected by Dr. Ping at Wenchow.

We take pleasure in naming this new species for Dr. Chi Ping, professor of zoology, Southeastern University, Nanking.

Family Dasyatidæ

3. Dasyatis zugei (Müller & Henle)

Chinese name, Tse-yao-yu (Stingray)

One specimen (No. 878), 272 mm. long with tail, collected by Dr. Ping at Chefoo.

Disk slightly broader than long; snout pointed, the margins nearly straight, the length 3.5 in that of disk; interorbital concave; two fins at base of tail, tail longer than disk, whip-like, with prominent fold on upper and lower sides; a long and strong spine at about end of first fourth of tail; eye about equal to diameter of spiracle which is immediately behind it. Color light brown above, white below.

Trygon zugei Müller & Henle, Plagiostomen, 168, pl. LIII, 1838, Nagasaki.
Family Acipenseridae

4. Acipenser sinensis Gray

Chinese name, Ging-yu (Sturgeon)

One specimen obtained in the Hongkew fish market in Shanghai. It was a young fish 51 cm. long, and is now preserved in the Ching Chong High School, Shanghai. It probably came from the lower part of the Yangtse River. The species inhabits the seas of China and is said to reach a length of 300 cm. or more.

Head 3; depth 5; eye 7; snout 2. Body armed with 5 rows of bony plates, the dorsal series containing 14 plates, the two lateral ones 41 each; ventrals 10 each; dorsal with one plate behind located in posterior part of body; anal with two small plates in its front and one behind; four barbels before mouth; pectoral near gill-opening; ventrals close to anal; one large bony plate on each opercle. Color, dark gray on back, lighter below.


Family Engraulidae

5. Coilia ectenes Jordan & Seale

Chinese name, Taou-yu (Knife-fish), from the sharp ventral edge.

Seven specimens (145, 166, 203, 207, 245, 255, and 275 mm. long respectively), from Hangchow, Chuchi and Nanking; No. 761 from the Yangtse River (Dr. Ping Coll.), the others Nos. 508 to 513 (Shaw Coll.).

Head 6.5 to 6.6; depth 5.8 to 7.7; eye about 7; interorbital width 3; V. 6; P. 16; snout 4.5 to 5.8; D. II, 11; A. 90 to 106; scales about 69. Six pectoral filaments, the longest reaching beyond origin of anal; maxillary tapering behind, extending to base of pectoral; distance between base of first dorsal ray and tip of snout about 4 in total length without caudal; gillrakers about 35 on lower limb of outer arch; abdominal serratures 49. Color, silvery white. Description based chiefly of the Ping specimen.
This species differs from *Coilia nasus* Schlegel, in the greater number of anal rays, the latter having only 85 according to Schlegel (Fauna Japonica, Poiss., p. 244).

The average length of this species is about 300 mm. They appear in the lower Yangtse and the Chientang River after April. They also appear in the lakes connected with the river. They do not seem to be found in inland waters in the winter. Chinkiang is famous for this fish which is much prized, the flesh being of delicate flavor, albeit with many small bones.


**Family Flutidae**

6. **Fluta alba** (Zuiew)

Chinese name, *Hwang-zang* (Yellow Mud Eel);
Japanese name, *Taunagi* (Rice-field Eel)

One specimen (No. 849), 246 mm. long, from Nanking.
Head 8.3 in distance from end of snout to anal opening; eye about 8 in head; snout 4; no scales. Body elongate, tail narrow and tapering to a point; origin of dorsal slightly in front, the ventral slightly behind anal opening. Color, yellowish; blackish above, orange below.
A common food fish in eastern China.
Basilewsky called it *Apterigia saccogularis*.


**Family Anguillidae**

7. **Anguilla japonica** Temminck & Schlegel

Chinese name, *Mur-yu* or *Mur* (Eel)

Two specimens, 390 and 495 mm. long respectively (Nos. 514 and 515), from Shanghai and Hangchow.
Head 3.4 in length to vent; depth 8; head and trunk 1.5 in rest of body; snout 5.3; maxillary 3.3 in head; interorbital 5.6; eye 2 in snout; distance between dorsal and anal origin 1.25 in head.
Color, dark above, white below; fins more or less pinkish; caudal black at tip.
Common in Eastern China.

_Anguilla japonica_ Temminck & Schlegel, Fauna Japonica, Poiss., 258, pl. CXIII, fig. 2, 1846.

Family _Muraenidae_

8. _Muraenesox cinereus_ (Forskal)
   
   Chinese name, _Ho-zang_ (Stork Eel)

   One specimen (No. 852), 345 mm. long, from Chefoo.
   Head 2.2 in length to vent; snout 4 in head; eye 2.1 in snout; jaws with several series of small teeth, anteriorly with canines; middle of vomer with several large conical teeth; two pairs of nostrils, the posterior opposite middle of eye; origin of pectoral above gill-opening; of dorsal, a little in advance of pectoral.
   Color, grayish brown above, whitish below.
   This species is reported also from Chekiang and southward to Canton.


Family _Cyprinidae_

9. _Sacocheilichthys variegatus_ (Temminck & Schlegel)
   
   Chinese name, _Loo-hen-yu_ (Buddha-fish)

   One specimen (No. 516), 87 mm. long, from Nanking.
   Head 4; depth 3.3; eye 3.1; interorbital 2.1; D. 9; A. 8; scales 5-40-5. Upper profile of snout convex; mouth inferior, horseshoe-shaped; lower jaw with pendent lateral lobes; no barbels; origin of dorsal fin nearer tip of snout than base of caudal.

_Leuciscus variegatus_ Temminck & Schlegel, Fauna Japonica, Poiss., 213, pl. CII, fig. 2, 1846.
10. **Parabramis pekinensis** (Basilewsky)

Chinese name, *Pein-yu* (Flat-fish; Chinese Bream)

Four specimens (Nos. 760, 586, 587 and 588), 152-212 mm. long, from Hangchow, Shanghai and Nanking.

Head 4; depth 3; eye 4 in head, greater than snout; D. II, 8; A. 34; V. 9; scales 11-52-9; second dorsal ray very strong, not serrated, about as long as head; upper jaw overlapping lower; pectoral shorter than head; scales moderate; mouth anterior; no barbels; origin of dorsal a little behind ventrals.


11. **Zezera rathbuni** Jordan & Seale

Chinese name, *Tson-chau-ting*

One specimen (No. 517), 186 mm. long from Nanking.

Head 5, its depth 1.45 in its length; depth 4.5; eye 7.4; snout 2.7; interorbital width 2.6; D. 8; A. 7; scales 7-56-6. Body elongate, head naked, rather blunt; barbel present, a little longer than snout.

Color in spirits, gray above, yellowish below with some silvery reflections.


12. **Cyprinus carpio** Linnæus

Chinese name, *Li-yu* (Carp)

One specimen (No. 518), 115 mm. long, from Chuchi.

Head 3.3; depth 3; eye 5; snout 2.8; D. III, 18; A. III, 5; scales 5-36-6; two pairs of barbels.

Abundant in lakes and rivers.

13. **Carassius auratus** (Linnaeus)

Chinese name, *Chi-yu* (Small Carp; Goldfish)

One specimen (No. 847), 162 mm. long, from Nanking.
Head 3.3; depth 3; eye 4; snout 4; D. II, 17; A. III, 5; P. 17; V. I, 8; scales 7-28-5.

Common everywhere in Eastern China.


14. **Myloleuciscus æthiops** (Bleeker)

Chinese name, *Tsou-yu* (Weed-eating Fish)

Two specimens (Nos. 764 and 589), 151 and 190 mm. long respectively, from Shanghai and Nanking.
Head 3.8; depth 3.75; eye 5.2; snout 3.5; interorbital width 2.1; D. I, 8; A. 10; P. 18; V. 9; scales 6-42-5; origin of dorsal at middle of body; origin of pectoral at gill-opening; ventrals nearly opposite dorsal. Anal midway between ventrals and caudal.

Color, light yellow, blackish above.

A common food-fish in ponds and lakes of Eastern China.


15. **Acheilognathus imberbis** Günther

*Parachilognathus imberbis* Bleeker

One specimen (No. 519), 57 mm. long, from Shanghai.
Head 3.8; depth 2.5; eye 3 in head, equal to snout; D. II, 12; A. II, 10; scales 6-34-5; interorbital width a little greater than eye; mouth small; no barbels; origin of dorsal a little nearer tip of snout than caudal; lateral line slightly curved downward.

Color, silvery; a bluish band along middle of side of tail.

We have compared our specimen with one in Stanford University collected at Tien Tsin by N. F. Drake and find them to agree perfectly.

*Acheilognathus imberbis* Günther, Cat., VII, 278, 1868, China.
16. **Acheilognathus asmussi** (Dybowski)

__(Acanthorhodens asmussi)__

One specimen (No. 520), 57 mm. long, from Shanghai. D. II, 16; A. II, 13. Closely related to *A. imberbis*, but with more numerous fin-rays.

17. **Culter recurviceps** (Richardson)

One specimen (No. 759), 202 mm. long, from Yangtse River, at Nanking.

Head 4; depth 3.2; eye 4.6; snout somewhat greater than eye, equalling interorbital width; D. II, 7; A. 28; scales 12-48-9; lateral line nearly straight; mouth subvertical; no barbels; caudal forked; second dorsal spine strong and smooth; pectoral extending to ventrals; interorbital space concave; maxillary not reaching orbit. Color, silvery.


*Culter albunus* Basilewsky, Nouv. Mém. Soc. Nat. Mosc., X, 1855, tab. 8, fig. 3.

18. **Hemibarbus barbus** (Schlegel)

Three specimens (Nos. 871, 590 and 591), 188, 215 and 175 mm. long respectively, from Hangchow and Nanking.

Head 4.1; depth 4.3; eye 4.2; snout 2.6; interorbital width 3.1; D. III, 7, the second spine strong, smooth and about length of head; A. II, 6; V. 10; P. about 19; scales 6-47-6, 4 between lateral line and ventral and 5 between it and anal; origin of dorsal a little nearer tip of snout than tip of caudal.

Many small black spots on back and on dorsal and caudal fins.

Our specimens agree with others from Formosa which we have examined in Stanford University.

*Gobio barbus* Schlegel, in Siebold’s Fauna Japonica, Poiss., 198, pl. 99, fig. 1, 1850.
19. **Pseudogobio chaoi** Evermann & Shaw, new species

Chinese name, *Ma-chi* (Horse Carp)

One specimen. Head 3.5; depth 4.5; eye 3; snout 2.3; interorbital width 4.5; D. II, 7; A. 7; V. 9; scales 6-38-5; mouth inferior, with 2 small barbels at each corner; origin of dorsal about midway of body; ventral somewhat behind dorsal. A series of round blackish spots above lateral line; dorsal with some black spots.

This species resembles *P. esocinus* Schlegel, but differs in the shorter head, shorter snout, and weaker and shorter barbels. From *P. drakei* Abbott (No. 6303, Stanford University) it differs in the longer head, larger eye and deeper body.

*Type*: No. 501, Mus. Calif. Acad. Sci., a specimen 97 mm. long, from Nanking, China.

It gives us great pleasure to name this species for Messrs. T. P. Chao and P. K. Chao, graduates of Southeastern University, who so kindly assisted the junior writer in collecting some of the specimens.

20. **Saurogobio dumerili** Bleeker

One specimen (No. 850), from Chefoo and two (Nos. 521 and 522), from Hangchow, 222, 226 and 227 mm. long, respectively.

Head 6; depth 8; eye 4.5; snout 2.8; interorbital width 3.1; D. 9; A. 8; scales large, 6-55-4. Body elongate, not compressed; snout blunt; mouth inferior; horseshoe-shaped; 4 barbels, their length equal to diameter of eye; origin of dorsal at beginning of second third of body length (in the Chefoo specimen the distance from snout to origin of dorsal is 2.7 in total length); pectoral nearly as long as head; origin of anal nearer base of caudal than to dorsal. Color silvery, the Chefoo example a little darker than those from Hangchow, probably because of manner of preservation.
21. **Squaliobarbus jordani** Evermann & Shaw, new species

Head 4.2 to 4.5; depth 4.3 to 4.6; eye 4.2 to 4.6; snout 3.3 to 3.6; interorbital width 2.2; D. 9; A. I, 7; scales 6-46-3, of moderate size, the lateral line low but terminating in the middle of the tail. Dorsal opposite ventral, its origin at middle of length of body; interorbital space flat; upper jaw slightly overlapping the lower; two minute barbels, one at each angle of mouth; caudal forked. Color, blackish-green above, pale below; a dark area on each scale forming rows of small black triangles with the apex pointing forward, about 6 rows on each side.

This species differs from *Squalibarbus curriculus* Richardson, in the advanced position of the ventrals, the more numerous scales in the lateral line, the fewer dorsal rays, and the presence of only 2 barbels.

Five specimens (Nos. 873, 523, 524, 525, and 502), from Hangchow, Nanking, and Shanghai, 120, 133, 141, 167, and 213 mm. long, respectively.

*Type:* No. 502, Mus. Calif. Acad. Sci., a specimen 213 mm. long, collected by Mr. Shaw at Hangchow.

We take pleasure in naming this species for Dr. David Starr Jordan to whom practically all American ichthyologists of the last half century owe their inspiration.

22. **Xenocypris davidi** Bleeker

One specimen (No. 526), 190 mm. long, from Hangchow. Head 4.7; depth 3.7; eye 3.7; snout equals eye, interorbital width 2.6; D. II, 8; A. 14; scales 10-74-7, the lateral line running along middle of body; second dorsal spine strong and smooth; ventrals below dorsal, their distance from snout nearly 2 in total length; origin of anal about midway between ventrals and caudal; mouth small, the upper jaw overlapping the lower; no barbels; caudal forked. Our specimen agrees well with the descriptions of *X. davidi* except that it has more scales in the lateral line.

*Xenocypris davidi* Bleeker, Sur. Cypr. China in Verh. Akad. Amsterd., XII, 1871, 56, tab. 6, fig. 4, **Yangtse River.**
Genus **Kendallia** Evermann & Shaw, new genus

*Type: Kendallia goldsboroughi* Evermann & Shaw, new species.

This genus is related to *Parapelecus* Günther, and is characterized by the more advanced position of the dorsal fin, the presence of spines in the dorsal, and the moderate length of the anal which has few rays.

The genus is dedicated to Dr. William Converse Kendall, for 23 years associate of, and co-worker with, the senior author in the United States Bureau of Fisheries, and one of the most discerning students of American fishes.

23. **Kendallia goldsboroughi** Evermann & Shaw, new species

One specimen. Head 4.5; depth 4.4; eye 4; snout 4; interorbital width 3.3; D. II, 7; A. I, 13; scales 8-46-3; pharyngeal teeth 3, 4, 1-4, 2.

Body similar to that of *Parapelecus* Günther (1889, from Kiu-kiang), but the dorsal is more advanced.

Body compressed, the entire abdominal edge trenchant; lateral line sharply decurved above the pectoral, running along the ventral side, rising again abruptly posteriorly to middle of caudal peduncle; mouth oblique; no barbels; insertion of pectoral below median line of body, as long as head; origin of dorsal nearer base of caudal than to snout; second dorsal spine strong; longest dorsal ray shorter than pectoral; insertion of ventrals at middle of total length; anal midway between dorsal and caudal; caudal well forked.

Color, bright silvery, blue-green on back.

*Type: No. 503, Mus. Calif. Acad. Sci., a specimen (No. 77) 153 mm. long, collected by Mr. Shaw at Hangchow.*

This species is named for Mr. Edmund Lee Goldsborough, for many years associated with the senior author and their mutual good friend, Dr. William Converse Kendall, in the study of fishes.
24. **Elopichthys bambusa** (Richardson)

   Chinese name, *Kan-yu*

   One specimen (No. 527), 250 mm. long, from Nanking.
   Head 3.7; depth 5.75; eye 6.6; snout 3.1; interorbital width 4; D. 12; A. 11; P. 18; V. 11; scales small, 18-114-5; pharyngeal teeth in 3 rows, 4, 3, 2-5, 1, 4, the outer 4 enlarged.

   Body elongate; head pointed; mouth terminal, the gape extending below front of eye; no barbels; nostrils at front of upper corner of eye; tongue well developed; gillrakers short; lateral line curved downward over pectoral, running along ventral side then ascending to middle of tail; dorsal origin behind midway of body, longest ray about 1.6 in head; insertion of pectoral low, near opercle, the fin shorter than dorsal; ventrals as long as pectorals, their origin slightly in front of dorsal, nearer snout than to caudal; anal midway between caudal and dorsal; depth of caudal peduncle equal to length of snout; tail deeply forked. Color, silvery, darker above.

   This species is said to feed largely upon other fishes. The adults attain a length of 4 feet or more.


25. **Parapelecus machærius** Abbott

   One specimen (No. 528), 155 mm. long, from Hangchow.
   Head 5; depth 4.5; eye 4; snout about 3.5; D. 10; A. 29; scales 68 in lateral line. Dorsal outline straight, ventral strongly convex, the whole edge trenchant; dorsal origin midway between base of caudal and edge of opercle; lateral line descending abruptly above pectoral. Color, silvery, darker above.


26. **Culticula emmelas** Abbott

   Four specimens (Nos. 529-532), 91, 105, 108 and 111 mm. long, from Hangchow.
Head 4.5; depth 4; eye 3.8; snout about 4; D. II, 7; A. II, 11; scales 8-47-5. Body elongate, dorsal and ventral outlines about equally curved; mouth terminal; lateral line curved downward; caudal deeply forked.


27. **Exoglossops geei** Fowler & Bean

One specimen (No. 533), 146 mm. long, from Hangchow.

Head 4.1; depth 3.2; eye 4.2; snout 3; D. III, 7; A. III, 6; scales 6-38-6. Body robust; caudal peduncle deep; mouth inferior; no barbels; dorsal fin opposite ventrals; lower lip with horny plate; interorbital space slightly convex.


**Family Cobitidae**

28. **Misgurnus anguillicaudatus** (Cantor)

Chinese name, *Nee-chu* (Mud Loach)

One specimen (No. 534), 175 mm. long from Chuchi, and one (No. 863) with body length of 83 mm. from Nanking.

Head 6; depth 7.5; eye 9.5; interorbital width 4.3; D. 7; A. 7; V. 6; scales very small, more than 130 in lateral line; many barbels, the longest 3.5 in head; origin of dorsal nearer caudal than end of snout; pectoral shorter than head.

Body and fins with numerous small black spots, probably myxosporidia.


**Family Bagridae**

29. **Liocassis longirostris** Günther

Chinese name, *Wai-yu*

Two specimens (Nos. 757 and 535), 119 and 224 mm. long respectively, from Nanking.
Head 3.5; depth 4.5; eye 10; interorbital width 3.2; snout 2.6; depth of caudal peduncle 4 in head; D. I, 7, the spine serrated; A. 17; P. I, 9, the spine strongly serrated; V. 6, its origin behind dorsal.

Body elongate; neck region triangular in cross-section; caudal peduncle compressed; snout conical; mouth inferior; teeth villiform; 8 barbels, those on upper jaw longest; eye very small, no free circular eyelid; occipital process naked; origin of dorsal midway between snout and long adipose fin; origin of ventrals behind dorsal.

Adults seen in the markets of Nanking and Chinkiang were more than 2 feet long.

*Liocassis longirostris* Günther, Cat. Fish., V, 87, 1864, *Japan*.

30. **Parasilurus asotus** (Linnaeus)

Chinese name, *Nyee-yu*

Three specimens (Nos. 536-538), 125, 153 and 245 mm. long, from Hangchow, Chuchi and Nanking.

Head 4.7; depth 7; eye 8.5; snout 3.7; interorbital width 2.1; D. I, 4; A. 80; width of mouth 1.7 in head. Snout depressed and rounded; teeth villiform; 4 barbels, those on upper jaw the longer; distance from end of snout to origin of dorsal about ⅓ total body length; anal near ventrals and confluent with caudal. Color, dark brown above, buffy below.


31. **Peltiobagrus fluvidraco** (Richardson)

Six specimens (Nos. 539-544), ranging from 15 to 227 mm. in length, from Hangchow and Chuchi.

Head 3.5; depth about 4; snout 3; interorbital width 2.4; D. I, 7; A. V, 15. Lower jaw shorter than upper; pectoral spine serrated on both edges; 8 barbels, those on maxillaries as long as head, outer mental barbels about 1.5 in head, the nasal and inner barbels about 3 in those on maxillaries. Color brownish.

32. **Clarias fuscus** (Lacépède)

One specimen (No. 870), 227 mm. long, from Nanking.

Head 4.5; depth 6.3; eye about 9; snout about 3; inter-orbital width about 2; D. 59; A. 45; 8 barbels, 2 pairs on the lower jaw, one on the nasal, and another on the maxillary which are the longest and extend to the pectorals; mouth inferior; teeth villiform; head granulated above, somewhat flattened; pectoral low, longer than snout, the spines serrated; ventrals small; anal not confluent with caudal. Color, brownish black.


**Family Hemirampphilæ**

33. **Hemirhamphus sajori** Temminck & Schlegel

One specimen (No. 874), from Chefoo.

Head 5; depth 2 in head; D. 16; A. 17; P. 13; eye 2.1 in snout, equal to interorbital width; upper jaw longer than broad, the lower shorter than head; vertex flat; origins of dorsal and anal opposite; insertion of ventrals a little nearer pectoral than caudal; pectoral 1.8 in head; caudal deeply forked; about 100 scales in lateral line; head scaled. Color, dark brown.

*Hemirhamphus sajori* Temminck & Schlegel, Fauna Japonica, Poiss., 246, pl. CX, fig. 2, 1846, Nagasaki.

**Family Soleidæ**

34. **Zebrias zebrinus** (Temminck & Schlegel)

One specimen (No. 879), 144 mm. long, from Chefoo.

Head 5.8; depth 2.6; D. 77; A. 66; scales 128, small, ctenoid; eyes on right side, the upper in advance of lower; mouth narrow, twisted around to the left side; caudal confluent with dorsal and anal; pectoral very small. Body with 12 black cross-bars.

*Solea zebrina* Temminck & Schlegel, Fauna Japonica, Poiss., 186, pl. XCV, fig. 1. 1846.
35. **Cynoglossus abbreviatus** (Gray)

Three specimens, 122, 251 and 254 mm. long respectively, from Hangchow; two 153 and 156 mm. long from Nanking, and one (No. 858), 141 mm. long from Ningpo.

Head 4.7 in total length; depth 3.7; snout 3. Three lateral lines on left side, one on right; upper eye slightly in advance of lower; nostrils 2, one between eyes, the other before lower angle of lower eye; lips not fringed. Color brown.

*Plagiura abbreviata* Gray, Ill. Ind. Zool., 1830-34, plates, without text.

**Family Ophicephalidæ**

36. **Ophicephalus argus** Cantor

*(O. pekinensis* Basilewsky)*

Chinese name, *Her-yu* (Black-fish)

Three young individuals (Nos. 550-552), 90 to 175 mm. long, from Hangchow, Chuchi and Shanghai.

Head 3.5; depth 6; eye 6.8; snout 5.8; interorbital width 5.7; D. 48; A. 32; scales 6-62-12.

Body elongate, anterior portion somewhat cylindrical; villiform teeth in jaws, vomer and palatines, with some larger teeth among them; three distinct mucous pores on under part of lower jaw and three on lower limb of opercle.

Back blackish, under parts white; many dark spots and cross-bars on sides of head and body; small dark dots on fins.

This species is predaceous, feeding largely on other fishes.


**Family Polyacanthidæ**

37. **Polyacanthus opercularis** (Linnaeus)

One specimen (No. 861), 51 mm. long, collected by Dr. Ping at Chefoo.

Head 3.3; depth 2.9; width of body 2 in length of head; eye 3.5 in head, rather large and prominent, equalling snout; mouth small, slightly oblique, gape not reaching to anterior of orbit. D. XIV, 4, the spines gradually lengthening from first
to last, tips of last ones hidden in membrane; A. XV, 13, the spines and rays hidden in thick membrane, the first ray produced into a long filament; no lateral line; scales weakly ctenoid, with rounded posterior margins, about 14 in a transverse, 30 in a longitudinal series; opercles, cheeks, and entire head scaly. Head with mucous pores especially along edge of preopercle. Dorsal beginning behind origin of pectoral. Gill-membranes forming a fold over isthmus. Dorsal and anal free from the caudal, but the long rays each extending backward over half the length of the acutish caudal, so that they enter into the outline of the fish giving the body a lanceolate appearance.

Color, blackish, a black spot on opercle.


**Family Mugilidæ**

38. *Mugil cephalus* Linnaeus

Chinese name, *Tse-yu* (Dark-fish)

Ten specimens (Nos. 553-560), 133 to 269 mm. long, from Hangchow.

Head 4.5; depth about 5; eye 5.5; D. IV-I, 8; A. III, 8; scales 38, no lateral line; upper lip with a single row of minute fringes; origin of pectoral above median line of body; insertion of ventrals between spinous dorsal and pectoral; anal about opposite second dorsal.


**Family Pampidæ**

39. *Pampus lighti* Evermann & Shaw, new species

One specimen from Nanking.

Head 3.45; depth 1.5; eye 3.3; snout shorter than eye; interorbital width 2.5; D. X, 48; A. VII, 45.

Body compressed and deep; scales very small; origin of pectoral at median line of depth; 2.4 in body; no ventrals: caudal
peduncle a little longer than eye; caudal fin deeply forked, lower lobe the longer, 2.1 in total length without tail; gill-openings restricted to the sides.

Color, bluish gray above and on fins, silvery below median line; caudal slightly reddish.

This species resembles *Pampus sinensis* but differs in the longer pectoral, more deeply forked caudal, whose lobes are unequal in length, shorter lower jaw, and the more pointed anterior portions of dorsal and anal.

From the common Chinese species, *Pampus argenteus*, this species differs in the greater number of spines and rays in the dorsal and anal fins.

**Type:** No. 504, Mus. Calif. Acad. Sci., a specimen (No. 855), 77 mm. long, collected by Professor Ping at Nanking.

This species is named for Dr. S. F. Light, sometime professor of zoology in Amoy University, now assistant professor of zoology, University of California, in recognition of his valuable studies of the Lancelets of the Amoy region.

**Family Moronidæ**

40. **Lateolabrax japonicus** (Cuvier & Valenciennes)

Chinese name, *Lou-yu*

Six specimens (Nos. 863 and 561 to 565), 102 to 246 mm. long. from Hangchow and Woosung.

Head 3.1; depth 3.8; eye 5; snout 3.3; interorbital width about 6, a little less than eye; D. XI or XII-I, 13 or 14; A. III, 7 or 8; scales 85 to 90 in lateral line. Mouth large, terminal; villiform teeth in both jaws and on palatines; no canines; 7 branchiostegals; opercle and preopercle armed with spines.

Color, with black spots on sides and on first dorsal fin.

A valuable and popular food fish.

Family Epinephalidæ

41. Siniperca chuatsi (Basilewsky)
Chinese name, Chua-yu; foreigners call it Mandarine Fish

Six specimens (Nos. 846 and 566 to 570), 133 to 196 mm. long, from Hangchow, Nanking, and Shanghai.

Head 2.4-2.8; depth 2.6-2.8; eye 6.3; snout 4.3-4.4; interorbital width 6.3; D. XII, 14; A. III, 9; V. I, 5; scales small, about 120 in lateral line. Mouth large, lower jaw much longer than the upper; opercle and preopercle armed with spines. One of the best food-fishes in China.


Family Lutianidæ

42. Lutianus hudsoni Evermann & Shaw, new species

One specimen (orig. No. 860).

Head 2.7; depth 2.4; eye 3.5; snout a little longer than eye; D. XI, 11; A. II, 8; scales 5-48-13; branchiostegals 7.

Body oblong, compressed; interorbital width a little greater than eye; maxillary reaching front of eye; preopercle serrate; pectoral low, below point of opercle, its length 3.3 in body; ventrals shorter than pectorals; first dorsal spine about 2 in 4th; dorsal rays longer than spines; distance from tip of snout to origin of dorsal equals depth of body; depth of caudal peduncle 2.5 in head; tail forked; teeth villiform. 4 canines in front of upper jaw and 5 in lower jaw; lateral line curved, running along dorsal side then to middle of tail; bases of dorsal and anal with scales. Color reddish.

This species resembles *Lutianus johnii* (Bloch) but differs in the fewer dorsal rays and the absence of a black spot below the soft dorsal.

*Type:* No. 505, Mus. Calif. Acad. Sci., a specimen 58 mm. long, collected at Nanking by Professor Ping.

This species is named for Captain Charles Bradford Hudson, most able American artist in depicting the life colors of fishes.
Family Hämulidæ

43. **Hapalogenys nigripinnis** (Temminck & Schlegel)

Chinese name, *King-fung* (Golden Wind)

One specimen (No. 858), 71 mm. long, from Ningpo.
Head 2.6; depth 2; eye 3.1; snout 2.9; interorbital width 4; D. XII, 14, fourth spine longest; A. III, 9; depth of caudal 3 in head; scales in lateral line 62.

Body oblong, high and compressed; mouth large; 4 large pores on lower side of mandible, some minute papillæ in front of them; preopercle serrate, opercle with 2 short spines. Color, reddish gray, darker bands not distinct; fins dark.

*Pogonias nigripinnis* Temminck & Schlegel, Fauna Japonica, Poiss., p. 59, pl. XXV, 1843.

Family Sciænidæ

44. **Collichthys lucidus** (Richardson)

Chinese name, *Tse-ser-yu* (Stone-head Fish)

One specimen (No. 856), 115 mm. long, from Wenchow.
Head 3.4; depth 3.3; eye 4.5; snout 4; interorbital width 2.4; D. IX, 28; A. II, 13; scales about 50. Body elongate; maxillary reaching posterior edge of orbit; teeth feeble, no canines; lateral line complete, high, curved at end of pectoral then straight to middle of caudal; dorsal spines short, about as long as snout; dorsal rays much longer; pectoral below median line of body, slightly shorter than head; ventrals near pectorals; depth of caudal peduncle 4 in depth of body; caudal fin longer than head.

Common in seas of China.


Family Drepanidæ

45. **Drepane punctata** (Gmelin)

Chinese name, *Ke-lung-tsang* (Coop-tsang fish)

One specimen (No. 877), 91 mm. long, from Ningpo.
Head 2.8; depth a little less than length; eye 3.1, 1.3 in snout; interorbital width greater than diameter of eye; D. IX,
21; A. III, 19; P. 17; V. I, 5. Body much compressed, deep; anterior dorsal spine concealed and directed forward; inter-spinous membranes deeply notched; pectoral long, falciform; scales moderate, about 60 in lateral line.


**Family Synancejidae**

46. *Inimicus japonicus* (Cuvier & Valenciennes)

Chinese name, *Laou-hoo-yii* (Tiger-fish)

One specimen (No. 868), 110 mm. long from Ningpo.

Head 3; depth 3.5; eye 7; snout 2.8; D. III-XIV, 7; A. II, 9. Body elongate, little compressed; head irregular in form; pectoral long, reaching past front of anal; ventrals adnate for their entire length; anal spines short; caudal fin rounded; lateral line with 15 filaments. Color, dark brown, with cross-band of black or red.


**Family Scorpaenidae**

47. *Sebastodes fuscescens* (Houttuyn)

One specimen (No. 872), 88 mm. long, from Chefoo.

Head 2.7; depth 2.8; eye 3.3, slightly exceeding snout; interorbital width 4.3; D. XII-I, 12; A. III, 7; P. 18; V. I, 5; lateral line with 46 pores; maxillary 2 in head.

Body oblong; lower jaw the longer; interorbital space slightly convex, spines lying close to surface; preopercle with 5 spines; dorsals long, the two connected slightly; and rounded; teeth villiform.

Color, dark brown with blotches on dorsal and sides.


*Sebastes schlegelii* Hilgendorf, S. B. Gesell. Naturf. Freunde, 171, one plate, 1880, Tokyo; *Hakodate*.
Family Platycephalidae

48. Thysanophrys spinosus (Temminck & Schlegel)

One specimen (No. 880), 105 mm. long, from Ningpo.
Head 2.5; depth 4.9; eye 3.2; snout 3.2 interorbital width 4 in eye; width of head 1.8 in the length; D. VIII-I, 8; A. III, 5; V. I, 5. Head broad and depressed, armed with spines; body depressed anteriorly, subcylindrical posteriorly; about 40 scales in lateral line; first dorsal above pectoral, second a little in advance of anal; ventral origin below base of pectoral; caudal rounded.

Platycephalus spinosus Temminck & Schlegel, Fauna Japonica, Poiss., 40, pl. XVI, figs. 1, 2, 1843.

Family Cottidæ

49. Trachidermis fasciatus Heckel
Chinese name, Sungkiang Lu-yu or Tse-sai Lu-yu

Five specimens (Nos. 866, and 571-574), 122 to 142 mm. long, from Sunkiang.
Head 2.8; depth 4.5; eye 6.5; snout 3.2; interorbital width 3.8; D. VIII, 19; A. 17; lateral line with 38 small pores. Head more or less depressed; body subcylindrical, compressed posteriorly; teeth fine, on both jaws, vomer and palatines; interorbital space concave, lower preopercular edge with 4 broad, short spines, the upper one curved upward.


Family Gobiidæ

50. Ctenogobius clarki Evermann & Shaw, new species
Chinese name, Yeo-boo-sao

Head 3.6; depth 6.2; eye 5.5, a little greater than interorbital width; D. VI, 16; A. 13 or 14; about 50 scales in lateral line.
Body oblong, slender, heaviest anteriorly, tapering to caudal; mouth rather large; teeth strong, flattened laterally:
origin of second dorsal a little in advance of anal; caudal long and rounded.

Five specimens (Nos. 507 and 580-583), 80 to 170 mm. long, from Hangchow, Shanghai and Chuchi.

Not very common; has some value as a food-fish.

Type: No. 507, Mus. Calif. Acad. Sci., a specimen 170 mm. long, collected by Mr. Shaw at Chuchi.

This species is named for H. Walton Clark, assistant curator of fishes in the California Academy of Sciences, in recognition of his valuable studies of the fauna and flora of Lake Maxinkuckee.

51. **Lophiogobius ocellicauda** Günther

One specimen (No. 859) 4½ inches long, from Wenchow, China.

Head 3.3 in body; depth 7.5; eye very small, 9 in head; snout 3 in head; D. IV-14; A. 13; scales 5-40-4, no pores in lateral line which simply appears as a depressed line.

Head very broad and flat, its width 4.1 in body; interorbital broad, slightly concave, bordered on each side by a high ridge; mouth wide, gape horizontal, extending to posterior margin of orbit; gill-membranes free from the isthmus; branchiostegals 5, very prominent, raised ridges beset with papillae or rudimentary flaps; pectoral base very broad, close to and parallel with gill-slit, the rays numerous, the fin long and acute, reaching beyond origin of anal, its length 1.3 in length of head; ventrals thoracic, united into a long, elliptical, fringed disk, the origin on a vertical with lower end of origin of pectorals. Teeth two-rowed in lower jaw, or rather in a narrow villous band, the outer row somewhat enlarged and curved inward; teeth of premaxillaries similar; lower jaw projecting beyond upper, its bluntly-rounded tip fitting into a broad notch of upper lip; marked anal papilla; scales weakly ctenoid, striate.

A striking feature of this fish is what might be termed its "hairiness" expressed by the lengthening of all the fin-rays into elongate hair-like projections, and by the presence of minute hair-like flaps on various parts of the body as on the
cheek and edges of the opercle and along the rays. Color, sordid blackish. An examination of more material may show this to be an undescribed species.


**Family Uranoscopidæ**

52. **Uranoscopus japonicus** Houttuyn

Chinese name, *Koh-yu* (Horned-fish)

One specimen (No. 848), 194 mm. long, from Ningpo. Head 3.3; depth 4.2; eye 6.2; snout longer than eye; D. IV, 14; A. 14; P. 16; V. 5. Cleft of mouth vertical, eyes on upper side of head; first dorsal small; teeth villiform, no canines; head covered with spines, one on the opercle and 3 on the sub-opercle, all directed downward; two small and 2 larger spines of horny structure on nape. Head and back brown, irregularly spotted with lighter.


**Family Pholidæ**

53. **Pholis gunnellus** (Linnaeus)

One specimen (No. 857), 104 mm. long, from Chefoo, which we with much hesitation identify with this species. Head 7.5; depth 8; eye 5, about same as snout; D. LXXV; A. II, 39; V. I, 1, P. 2 in head; scales very small, no lateral line. Body long and compressed; head small, naked; mouth oblique; maxillary reaching front of pupil; interorbital with a narrow ridge; origin of dorsal fin as far behind nape as nape is behind middle of eye. Color, some dark bars on body; spots on dorsal not evident. Study of more adequate material would probably show this to be distinct from the Atlantic species.

Family Cebidichthyidae

54. Zoarchias glaber Tanaka

One specimen (No. 869), 110 mm. long, collected by Professor Ping at Nanking, agrees fairly well with Tanaka's description.

Head 6.3; depth 12; about 2 in head; eye 8; snout 4; rather short and pointed; D. XXXI, spines short, stout, depressed in a groove on back; one anal spine; soft dorsal and anal connected with rounded caudal. Color, blackish, a lighter colored line along each side of back; soft dorsal and caudal somewhat mottled.


Family Tetraodontidae

55. Spherooides ocellatus (Linnaeus)

Chinese name, Hoo-dung

Four specimens (Nos. 576-579), 133 to 165 mm. long, from Hangchow, and one 82 mm. long, from Woosung.

Head 3; depth 3.5; D. IV, 12 or 13; A. III, 10. Back covered with minute spines from near interorbital space to dorsal fin; abdomen entirely covered with similar spines; sides of body naked.

A black yellowish-edged band across back, ending in a more or less yellowish-edged spot. In some specimens there are two black spots on each side of body instead of the cross-bars. In one specimen the dorsal bar is much broader.

Kiangyiu is famous for the cooking of Hoo-dung, the people there having a special technique and skill in removing the poison of the ovaries and preparing this fish so that it is the nicest dish they have.

EXPEDITION OF THE CALIFORNIA ACADEMY OF SCIENCES TO THE GULF OF CALIFORNIA IN 1921

MARINE MOLLUSCA OF THE ORDER OPISTHOBRANCHIATA

BY

FRED BAKER

AND

G. DALLAS HANNA

This is the second paper treating of the marine mollusks collected by the expedition sent to the Gulf of California in 1921 by the California Academy of Sciences. The greater part of the identifications and diagnoses have been prepared by the senior author, the efforts of the junior author having been largely confined to sundry comparisons, editorial work and the preparation of the illustrations.

We are indebted to Mr. A. M. Strong for assistance in arriving at some definite conclusion as to the nomenclature of some of the more difficult species.

* This is No. 35 of the series of Gulf Expedition papers.
1A map showing all the islands, etc., visited will be found in the General Account of this Expedition by Joseph R. Slevin, in these Proceedings, Vol. 12, No. 6, 1923, pp. 55-72; copies of this publication can be supplied at nominal cost.
2The first, treating of the Triphoridae by Fred Baker is found in Proc. Calif. Acad. Sci., 4th Ser., Vol. 15, No. 6, 1926, pp. 223-239, pl. 24.

April 22, 1927
The differentiation of genera in this group of mollusks is unsatisfactory and our endeavor has been to place the following species in those currently recognized groups which have related forms; when geno-types are investigated, basic changes will possibly be required.

1. **Acteocina angustior** Baken & Hanna, new species

   Plate 4, figure 5

Shell small, imperforate, very solid, narrowly cylindrical, with nearly parallel sides, everywhere marked by fine growth lines and minute, irregular, incised spiral lines; shining, whitish; nucleus small, but prominent, glassy, consisting of about one and a quarter planorboid whorls tilted to a nearly vertical position, and immersed in the succeeding postnuclear whorls not more than one-sixth of its diameter; postnuclear whorls about three, slightly convex, the upper nearly horizontal, the succeeding ones with an increasing downward slope; sutures channeled, slightly on the first whorl, deeply on the last, there producing a very prominent, sharp carina; spire rather short; aperture about four-fifths the length of the shell, beginning in a deep posterior notch formed by the channeled suture, the posterior half narrow, the anterior broadening into an elongate oval; outer lip sharp, beginning in the carina of the last whorl, sweeping downward with a moderate curve and continuing nearly straight to a point opposite the columellar fold and parallel with the inner lip for about two-fifths of the length of the shell, there joining the rounded basal lip; basal lip forming nearly a quadrant of a circle and joining the columella at about a right angle; columella only slightly curved, subvertical, twisted above to form a narrow, prominent spiral fold which disappears within the cavity of the shell; columella and columellar fold separated from the body of the shell by a rather broad, shallow groove also extending into the cavity of the shell; inner lip straight above, bounded below by the columellar groove, with a narrow callus which extends over the columella. Length, 5.4; diameter, 2.0 mm.
Holotype: No. 2513, Mus. Calif. Acad. Sci., with four paratypes dredged in from two to four fathoms in Puerto Escondido, Lower California.

This is the most common form of Acteocina found by the Expedition, having been taken, generally in the dredge, at La Paz, San Francisquito Bay, San Evaristo Bay, Coyote Bay in Concepcion Bay and San Luis Gonzaga Bay, Lower California, and on the following islands in the Gulf of California: Espiritu Santo, Carmen, and at three stations on San Jose. The species is very constant in shape, varying only in size and the height of the spire. Most specimens are more shining than the type and, in a considerable number, there is a suspicion of faint spiral banding in grayish, too indistinct to be definitely located. The spire is suggestive of Acteocina culcitella Gould, in the deep sutures and high carina, but the shell is much smaller, so far as known it has no epidermis and it is distinctly cylindrical instead of spindle-shaped as is A. culcitella.

2. Acteocina carinata (Carpenter)

Tornatina carinata Carpenter, Maz. Cat., 1856, p. 171; type locality, Mazatlan, Mexico.

This species was taken in Tepoca Bay, Sonora; La Paz, Agua Verde Bay, San Evaristo Bay, and San Luis Gonzaga Bay, Lower California; and on Espiritu Santo, Carmen, Monserrate and San Jose islands in the Gulf of California.

3. Acteocina inculta (Gould)


This species was taken in Tepoca Bay, Sonora; in Coyote and San Ignacio Bays in Concepcion Bay, and San Francisquito Bay, Lower California; and on Carmen, Sal si Puedes, Espiritu Santo and San Jose islands in the Gulf of California.
4. **Atys chimera** Baker & Hanna, new species

Plate 4, figure 4

Shell elongate-ovoid, shining, translucent, white, growth lines rather pronounced, especially towards the outer lip, with about nine incised spiral lines posteriorly and about sixteen anteriorly, separated by a narrow, clear space above the middle of the shell, the lines being unequally spaced and closer towards the extremities; obliquely truncate above, the apex narrowly, falsely umbilicate, the growth lines showing very plainly and dipping deeply into the cavity; aperture as long as the shell, showing a well rounded notch or posterior canal as the outer lip rises from the edge of the false umbilicus, narrow for the first three-fifths, then widening sharply; outer lip sub-angulate above, very moderately convex as it proceeds nearly parallel with the upper portion of the inner lip to join the basal lip which is sharply convex and slightly effuse; columella nearly straight below, sharply concave above, with a strong callus, reflexed to partially cover the deep and moderately large umbilicus and extending thinly over the lower portion of the inner lip. Length, 6.8; diameter, 3.3 mm.

**Holotype:** No. 2514, Mus. Calif. Acad. Sci., dredged in shallow water in **Puerto Escondido, Lower California.** Four young shells were dredged in about four fathoms off the main wharf at La Paz, and two others were taken in one to two fathoms in Coyote Bay, Concepcion Bay, all on the Gulf side of Lower California.

Carpenter’s description of *A. casta* is so vague and indefinite that identifications based thereupon would be entirely untrustworthy. *A. nonscripta* Adams, a species ascribed to San Diego by Carpenter, is much broader in proportion to length.

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5. **Bullaria gouldiana** Pilsbry


*Localities represented*

Pelican I.  
Sal si Puedes I.  
Isla Partida  
Bellandra Bay, Carmen I.  
Agua Verde Bay, L. C.  
San Jose I., Salt Works  
La Paz, L. C.  
Ceralbo I.  
Tepoca Bay  
Carmen I., Salt Works  
Angeles Bay, L. C.  
San Luis I., Inner Lagoon  
San Francisco I.

6. **Bullaria punctulata** (A. Adams)


Specimens, mostly young, of this rather common species were taken at the following places on the Gulf side of Lower California: La Paz, Puerto Escondido, Coyote Bay in Concepcion Bay, San Evaristo Bay and San Luis Gonzaga Bay; on the following islands in the Gulf of California; Espiritu Santo, two stations, and San Jose, three stations.

7. **Cylichnella defuncta** Baker & Hanna, new species

Plate 4, figure 3

Shell very small, ovate-cylindrical, somewhat narrowed above, thin, smooth, except for minute growth lines showing over part of the surface; umbilical end with eight, apical end with seven distinct spiral lines; translucent-whitish; apex obliquely truncate, the apical lip only moderately elevated, persectively umbilicate, showing about three distinctly convex whorls inside; outer lip thin, beginning at the edge of the apical umbilicus, rising very gradually to a subangulation at the upper, outer portion of the aperture, thence descending in a nearly straight, but slightly diverging line to a point slightly below the middle of the shell, from which point it rounds in a
gradually increasing curve into the broadly effuse basal lip; basal lip rounding rather sharply into the columella, producing a broad, prominent tooth; aperture as long as the shell, only slightly produced above, narrowest near the middle, elongate-subpyriform below; columella light, but rather broad, slightly revolute, somewhat reflexed but not covering the large and deep umbilicus; a moderate callus extending narrowly the length of the inner lip. Length, 2.6; diameter, 1.6 mm.

_Holotype:_ No. 2515, Mus. Calif. Acad. Sci., and about twenty others were dredged in two to four fathoms in _Amortajada Bay, San Jose Island, Gulf of California_. Specimens were also taken off the Salt Works on San Jose Island and off Carmen Island, Gulf of California.

In some shells the columellar tooth, instead of being widened and rendered indistinct by the callus, is a rather narrow, ascending spiral fold formed by the continuation of the basal lip and sharply truncating the columella anteriorly.

The species somewhat resembles _Cylichna brevissima_ A. Adams, from Chinese waters, but the Gulf species is proportionately narrower and lacks the central constriction.

8. _Cylichnella fantasma_ Baker & Hanna, new species

Plate 4, figure 6

Shell rather large for the genus, narrowly ovate-cylindrical, contracted at each end, everywhere marked by distinct growth lines and well marked incised spiral lines, the latter distinct and discrete at the extremities but more crowded and indistinct in the middle section, translucent white, slightly shining; apical umbilicus narrow, marked only by the entering growth lines; apical lip rising nearly vertically from the edge of the apical umbilicus for about three-fourths of a millimeter, then bending nearly at a right angle and continuing sinuously over the top of the aperture to join the outer lip, slightly effuse; outer lip thin and sharp, moderately and nearly evenly convex; basal lip somewhat fractured but evidently scarcely effuse and
nearly evenly rounded to join the columella without a fold; inner lip more convex than the outer, with a thin, narrow callus; aperture as long as the shell, narrowest towards the middle, wider opposite the apical umbilicus, narrowly subovate below; columella rather narrow and slightly twisted, concave, covered by a moderate callus which is obliquely truncate below, reflexed to partially hide the rather narrow umbilicus and spreading more broadly over the parietal wall. Length, 8.9; diameter, 4.0 mm.

_Holotype_: No. 2516, Mus. Calif. Acad. Sci., taken in Isthmus Bay, Espiritu Santo Island, Gulf of California; others were taken in San Gabriel Bay, Espiritu Santo Island and in San Luis Gonzaga Bay, Lower California.

The species somewhat resembles _Cylichnella attonsa_ (Carpenter), but it has more convex sides, making it more spindle-shaped; the aperture extends farther above the apex, the basal lip is more narrowly rounded, the incised spiral lines are much more distinct, and the peculiar angulation near the beginning of the apical lip, which is more or less discernible in most of the specimens taken, is wanting in _C. attonsa_.

9. **Haminoea angelensis** Baker & Hanna, new species

_Plate 4, figure 1_

Shell very thin and fragile, translucent, grayish-yellow, globose-oval, bulæiform, only slightly narrowed above; surface sculptured with faint growth lines and showing minute, wavy, microscopic, spiral, incised lines which are rather more distinct and discrete towards the base; vertex narrowly and shallowly impressed but not umbilicate; lip arising near the center of the apical depression, slightly revolute as it passes upward and outward to the slightly effuse apical lip, curving quite abruptly into the outer lip; curve of the outer lip increasing regularly downward until it passes into the nearly circular basal lip; columella very slightly folded above, rather strongly curved, with a heavy, reflexed callus forming a long, narrow

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umbilical chink and extending over the whole of the inner lip; aperture narrow above, very broad below. Length, 7.2; diameter, 5.6 mm. A broken shell taken in the same dredge haul as the type measures: length, not less than 12 mm.; diameter, 8.3 mm.

*Holotype:* No. 2517, Mus. Calif. Acad. Sci., was dredged in from four to six fathoms in Angeles Bay, Lower California, on the so-called “Sea Lettuce”; several others were taken at the same locality and single specimens were taken at San Luis Gonzaga Bay, and in Coyote Bay, Concepcion Bay, Lower California. Other localities are Ensenada de Santa Teresa, Monserrate Island; San Francisquito Bay and Isthmus Bay, Epipritu Santo Island.

The small size and color readily distinguish the species from *H. vesicula* Gould of the west side of Lower California. When the periostracum is removed the shell is thin and delicate, translucent-white, and shows the spiral striations very distinctly. The young shells show the growth lines and spiral incised lines more distinctly than mature individuals. *H. cymbiformis* Carpenter is an indeterminate species described from a very minute unique specimen. *H. angelenis* differs from all other species of *Haminoea* described from this coast in the breadth of the upper portion, which gives it the facies of a *Bullaria*.

10. *Haminoea* strongi Baker & Hanna, new species

Plate 4, figure 2

Shell pale green when covered with epidermis; marked with distinct growth lines and exceedingly fine spiral striations; apex depressed but not umbilicate; aperture greatly expanded and longer than body whorl; outer margin of body whorl rounded, tapering to a somewhat acute apex but without a compound, concave curve; parietal wall heavily covered with a deposit of white testaceous material which is rough and more or less completely covered with small conical projections. Length, 14.1; diameter, 10.2 mm.

This species was found abundantly in the Gulf, the following localities being represented:

- San Esteban Island
- Granite Island
- Coronados Island
- Tepoca Bay
- San Luis Gonzaga Bay
- San Marcos Island
- Puerto Refugio

- Georges Island
- Isla Raza
- Sal si Puedes Island
- Los Animas Bay
- San Luis Island
- Angel de la Guardia Island
- Guaymas Bay

The relationship of the species is clearly with H. virescens Sowerby and what has passed under that name from the west side of Lower California but the validity of which is to be doubted. Thus, shells from San Diego are very much larger, have larger body whorls, proportionately, and, most important of all, the outer boundary of the body whorl has a decided compound curve as the apex is approached, one portion being definitely concave; this latter is true to probably a greater extent in the true H. virescens.

11. *Retusa gonzagensis* Baker & Hanna, new species

Plate 4, figure 8

Shell very small, rather broadly cylindrical, the right side straighter than the left, slightly narrowed above, dull white, scarcely shining; sculpture limited to irregular growth lines and a few incised spiral lines about the base; apex almost horizontally truncate, with a narrow umbilicus nearly filled by the callus of the inner lip; outer lip beginning in the apical callus, not effuse above, rising but slightly and rounding broadly into the vertical portion which is nearly straight for fully half of the length of the shell, extending in a gradually increasing curve into the basal lip; basal lip scarcely effuse, moderately rounded throughout most of its course, then bending up sharp-
ly to form a prominent, heavily calloused, ascending spiral fold; inner lip very slightly more convex above than the outer lip, the curve increasing gradually below, covered throughout by a very heavy callus extending over the parietal wall to join that of the columella, and sharply defined in a nearly straight line on the body whorl; aperture as long as the shell, with nearly parallel sides and moderately open above, subpyriform below; columella strongly curved, defined above and below by heavy ascending and entering spiral folds, the whole covered by a very heavy, broad, slightly concave callus defining a long, shallow umbilical chink. Length, 2.9; diameter, 1.6 mm.

_Holotype:_ No. 2519, Mus. Calif. Acad. Sci., dredged in shallow water with five smaller shells, in _San Luis Gonzaga Bay, Lower California._

The species is definitely marked by the slight obliquity of the apex, and by the peculiar columella with two widely separated spiral folds and the broad, concave callus distinctly raised above the level of the inner lip and parietal wall. All of these criteria are well defined in all of the specimens taken. The writers have seen no figure or shell which closely resembles it.

12. _Retusa paziana_ Dall

_Plate 4, figure 7_


Specimens of this species were dredged in rather shallow water in Puerto Escondido and San Luis Gonzaga Bay, Lower California, and in Amortajada Bay, San Jose Island, Gulf of California.
Plate 4

Fig. 1. *Haminoea angelensis* Baker & Hanna, new species. *Holotype; No. 2517 (C.A.S.) from Angeles Bay, Lower California; length, 7.2 mm.; p. 129.

Fig. 2. *Haminoea strongi* Baker & Hanna, new species. *Holotype; No. 2518 (C.A.S.) from San Esteban Island, Gulf of California; length, 14.1 mm.; p. 130.

Fig. 3. *Cylichnella defuncta* Baker & Hanna, new species. *Holotype; No. 2515 (C.A.S.) from Amortajada Bay, San Jose Island, Gulf of California; length, 2.6 mm.; p. 127.

Fig. 4. *Atys chimera* Baker & Hanna, new species. *Holotype; No. 2514 (C.A.S.) from Puerto Escondido, Lower California; length, 6.8 mm.; p. 126.

Fig. 5. *Acteocina angustior* Baker & Hanna, new species. *Holotype; No. 2513 (C.A.S.) from Puerto Escondido, Lower California; length, 5.4 mm.; p. 124.

Fig. 6. *Cylichnella fantasma* Baker & Hanna, new species. *Holotype; No. 2516 from Isthmus Bay, Espiritu Santo Island, Gulf of California; length, 8.9 mm.; p. 128.

Fig. 7. *Retusa paziana* Dall. *Plesiotype, No. 2520 (C.A.S.) from Espiritu Santo Island, Gulf of California; originally in the collection of Fred Baker; length, 2.3 mm.; p. 132.

Fig. 8. *Retusa gonzagensis* Baker & Hanna, new species. *Holotype; No. 2519 (C.A.S.) from San Luis Gonzaga Bay, Lower California; length, 2.9 mm.; p. 131.
VI*

EXPEDITION OF THE CALIFORNIA ACADEMY OF SCIENCES TO THE GULF OF CALIFORNIA IN 1921

GEOLOGY AND PALEONTOLOGY

BY

G. DALLAS HANNA AND LEO GEORGE HERTLEIN

Department of Paleontology

INTRODUCTION

The expedition sent to the Gulf of California by the California Academy of Sciences in the spring of 1921 was accompanied by Dr. Fred Baker of San Diego. He collected living and fossil mollusks extensively for the Academy and the present paper is a result of a study of the fossils. We have also included those from the same region found in the collections of Leland Stanford Junior University. One species is given which was reported by Dr. Dall from the Pliocene of San Juan. Kitchen midden material, subfossils, and the species from known Pleistocene localities, are not listed in the check-list but are given under the separate localities.

* This is No. 36 of the Gulf Expedition papers.

1A map showing all the islands, etc., visited will be found in the General Account of this Expedition by Joseph R. Slevin, these Proceedings, Vol. 12, No. 6, 1923, pp. 55-72; copies of this publication can be supplied at nominal cost.

April 22, 1927
The check-list, admittedly incomplete, will give some indication of the fauna of the upper Pliocene found on the Gulf coast of Lower California and on some of the islands in the Gulf.

We are indebted to Dr. Baker, not only for the responsibility of making the collections and field notes but for the use we have been obliged to make of the very large collection of living mollusks he assembled; a great deal of this collection has been identified by Dr. Baker, but the results, as yet, have been published only in part. The late Mr. Eric Knight Jordan kindly determined some of the species for us. Acknowledgment is also due Prof. James Perrin Smith, of Leland Stanford Junior University for permission to study the Gulf region collections in that institution; also Mrs. Ida S. Oldroyd has given permission to study certain living shells in the conchological collection of the same institution.

Little is known concerning the detailed geology of the Gulf coast of Lower California and the fact that neither of the authors was on the expedition makes this paper chiefly a faunal study. Most of the Pliocene beds have low dips and for the most part they are made up of medium grained sandstones; at some localities the rocks are somewhat calcareous although they cannot be generally referred to as limestone. No fossils older than Pliocene were found.

**Review of Earlier Work of Gulf Region Geology**

A German scientist Grewingk described the geology of parts of the Gulf of California region in 1847.

In 1869, J. Ross Browne referred to beds near Loreto and considered them to be of Post-Pliocene age. He stated: "Half a dozen miles north of Loreto is a group of hills of Post-Pliocene age, highly fossiliferous. The largest of these, perhaps 600 feet high, is known as Cerro de los Ostiones. The fossils are in a pretty good state of preservation [and] are all living species, but the variety is not very great." Whether the

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³ Resources of the Pacific States and Territories, 1869, p. 116.
beds referred to by Browne are of Pliocene or Pleistocene age cannot be definitely ascertained as yet. Pliocene beds, however, do occur near Loreto.

Fuchs\(^4\), in 1886, considered the gypsum deposits about Santa Rosalia to be of late Miocene or early Pliocene age. Dall\(^5\), in 1903, listed \textit{Phacoides xantusi} Dall (formerly \textit{P. childreni} Gray) from the "Pliocene of San Juan," Gulf of California. Arnold\(^6\), in 1906, described a Pecten and listed a few other species from Santa Rosalia, and stated that the beds were probably of Miocene age. Wittich\(^7\), in 1909 and 1911, referred to beds in the Cape region which appeared to him to be of Pliocene age. Pliocene, referred to the Salada, was mapped by geologists of the Marland Oil Company\(^8\) in 1924, over various areas along the Gulf coast of Lower California. Johnston\(^9\), in 1924, referred to Pliocene beds at various localities along the Gulf coast of Lower California as well as on some of the islands in the Gulf. Hertlein\(^10\), in 1925, referred to beds in the vicinity of Santa Rosalia as "Carrizo" in age following Arnold; these beds were considered to be of Pliocene age. At the same time Pliocene pectens were listed from many other localities in Lower California. Hanna\(^11\), in 1926, referred to the Pliocene of San Juan as referred to by Dall. The same year, E. K. Jordan & Hertlein\(^12\), in a discussion of the correlation of the Pliocene beds on Maria Madre Island stated: "The beds are not far removed in age from the upper Pliocene of Loreto, Santa Antonita Point, San Jose Island, and San Marcos Island, in the Gulf of California region." In a later paper in 1926 the same authors\(^13\) stated that the Pliocene fauna of Maria Madre Island is more closely related to the Pliocene of the Gulf of California region than to that of Cedros Island and Turtle Bay and that the Maria Madre Island fauna might be younger than the latter.

\(^8\) Bol. del Petroleo, Vol. 18, No. 1, 1924, opposite p. 52.
Check-List of Pliocene Species

Echinoidea

*Clypeaster testudinalis* Gray; Santa Antonita Point, Loc. 795 (C.A.S.).

*Encope grandis* (?) Agassiz; Carmen Island, Loc. 828 (C.A.S.).

Coelenterata

Coral; Carmen Island, Loc. 826a (C.A.S.).
Coral; Carmen Island, Loc. 828 (C.A.S.).
Coral; Santa Antonita Point, Loc. 795 (C.A.S.).
Coral; Monserrate Island, Loc. 836 (C.A.S.).

Pelecyphoda

*Anomalocardia subimbricata* Sowerby; Santa Antonita Point, Loc. 795 (C.A.S.).

*Antigona multicostata* Sowerby; Coronados Island, Loc. 796 (C.A.S.).

*Arca grandis* Broderip & Sowerby; Carmen Island, Loc. 828 (C.A.S.).

*Arca multicostata* Sowerby; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 826a; 798; 830 (C.A.S.); Monserrate Island, Loc. 836 (C.A.S.); Las Galeras Island, Loc. 837 (C.A.S.); Ceralbo Island, Loc. 840 (C.A.S.).

*Arca pacifica* Sowerby; Santa Antonita Point, Loc. 795 (C.A.S.).

*Arca reeviana* Orbigny; Carmen Island, Locs. 798; 830 (C.A.S.).

*Cardium biangulatum* Sowerby; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 828 (C.A.S.).

*Cardium consors* Sowerby; Coronados Island, Loc. 796 (C.A.S.).

*Chama sp.*; Santa Antonita Point, Loc. 795 (C.A.S.).

*Chione succincta* Valenciennes; Santa Antonita Point, Loc. 795; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Locs. 798; 830 (C.A.S.); Pond Island, Loc. 838 (C.A.S.); Pelican Island, Loc. 841 (C.A.S.).

*Codakia colpoica* Dall; Santa Antonita Point, Loc. 795 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.); Loreto, Locs. 797; 844 (C.A.S.); Carmen Island, Locs. 798; 830 (C.A.S.).

*Cyathodonta undulata* Conrad; Santa Antonita Point, Loc. 795 (C.A.S.).

*Divaricella churnea* Reeve; Carmen Island, Loc. 828 (C.A.S.).

*Glycymeris gigantea* Reeve; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 798; 830 (C.A.S.).

*Glycymeris multicostata* Sowerby; Santa Antonita Point, Loc. 795 (C.A.S.); Carmen Island, Loc. 830 (C.A.S.).

Macrocallista aurantiaca Sowerby; Santa Antonita Point, Loc. 795 (C.A.S.).

Macrocallista squalida Sowerby; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Locs. 798; 828; 830 (C.A.S.).

Margaritifera mazatlânica Hanley; Coronados Island, Loc. 796 (C.A.S.); Ceralbo Island, Loc. 840 (C.A.S.).

Metis excavata Sowerby; Loreto, Loc. 797 (C.A.S.).

Ostrea fisheri Dall; Espíritu Santo Island, Loc. 833 (C.A.S.); Ceralbo Island, Loc. 840 (C.A.S.).

Ostrea megodon Hanley; Loreto, Loc. 794 (C.A.S.); Santa Antonita Point, Loc. 795 (C.A.S.).

Ostrea vespertina Conrad; Santa Antonita Point, Loc. 795 (C.A.S.); Loreto, Loc. 797 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.); Pond Island, Loc. 838 (C.A.S.); San Jose Island, Loc. 839 (C.A.S.).

Ostrea sp.; Santa Antonita Point, Loc. 795 (C.A.S.); Loreto, Loc. 844 (C.A.S.).

Ostrea sp.; Carmen Island, Locs. 798; 830 (C.A.S.).

Panope generosa Gould; Loreto, Loc. 797 (C.A.S.).

Pecten (Plagiopecten) cf. abietis Jordan & Hertlein; Santa Antonita Point, Loc. 795 (C.A.S.).

Pecten (Patinopecten) bakeri Hanna & Hertlein; Loreto, Loc. 794 (C.A.S.).

Pecten (Pecten) bósci Hanna & Hertlein; Santa Antonita Point, Loc. 795 (C.A.S.); Monserrate Island, Loc. 835 (C.A.S.).

Pecten (Plagiopecten) callidus Hertlein; San Jose Island, Loc. 839 (C.A.S.).

Pecten (Pecten) corrizoensis Arnold; Santa Antonita Point, Loc. 795 (C.A.S.).

Pecten (Pecten) cataractes Dall; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 828 (C.A.S.).

Pecten (Plagiopecten) circularis Sowerby; Loreto, Locs. 794; 797; 844; 845 (C.A.S.); Santa Antonita Point, Loc. 795; Carmen Island, Locs. 798; 830; 826a (C.A.S.); Las Galeras Island, Loc. 837 (C.A.S.); San Jose Island, Loc. 839 (C.A.S.); San Marcos Island. Loc. 149 (L.S.J.U.).

Pecten (Chlamys) dallasi Jordan & Hertlein; Santa Antonita Point, Loc. 795 (C.A.S.).

Pecten (Plagiopecten) deserti Conrad; Santa Antonita Point, Loc. 795 (C.A.S.); Carmen Island, Locs. 798; 830 (C.A.S.).

Pecten (Plagiopecten) invalidus Hanna; San Jose Island, Loc. 839 (C.A.S.).

Pecten (Plagiopecten) mendenhalli Arnold; Santa Antonita Point, Loc. 795 (C.A.S.).
Pecten (Amusium) cf. mortoni Ravenel; Santa Antonita Point, Loc. 795 (C.A.S.).

Pecten (Pecten) refugioensis HERTLEIN; Santa Antonita Point, Loc. 795 (C.A.S.).

Pecten (Pecten) stearnsii DALL; Loreto, Loc. 794 (C.A.S.); Santa Antonita Point, Loc. 795 (C.A.S.); San Jose Island, Loc. 839 (C.A.S.).

Pecten (Lyropecten) subnodosus SOWERBY; Loreto, Locs. 794; 844 (C.A.S.); Santa Antonita Point, Loc. 795 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.).

Pecten (Patinopecten) sp.; Loreto, Loc. 794 (C.A.S.).

Phacoides lampros DALL; Carmen Island, Loc. 828 (C.A.S.).

Phacoides nutalli CONRAD; Carmen Island, Loc. 828 (C.A.S.).

Phacoides xanthus DALL; "Pliocene of San Juan".

Placunamonia cf. hannibali JORDAN & HERTLEIN; Santa Antonita Point, Loc. 795 (C.A.S.).

Semele flavescens GOULD; Carmen Island, Locs. 798; 830 (C.A.S.).

Spondylus crassisquama LAMARCK; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 829 (C.A.S.); San Jose Island, Loc. 839 (C.A.S.).

Spondylus sp.; Santa Antonita Point, Loc. 795 (C.A.S.).

Venericardia crassicostata SOWERBY; Coronados Island, Loc. 796 (C.A.S.).

Gastropoda

Acteocina angustior BAKER & HANNA; Carmen Island, Loc. 828 (C.A.S.).

Architectonica granulata SOWERBY; Santa Antonita Point, Loc. 795 (C.A.S.).

Arcularia complanata POWIS; Carmen Island, Loc. 828 (C.A.S.).

Cancellaria obesa SOWERBY; Coronados Island, Loc. 796 (C.A.S.).

Cassis coarctata SOWERBY; Monserrate Island, Loc. 836 (C.A.S.).

Cerithium stercus-muscum VALenciennes; Carmen Island, Locs. 798; 830 (C.A.S.).

Columbella fuscata SOWERBY; Coronados Island, Loc. 796 (C.A.S.).

Conus regularis SOWERBY; Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 828 (C.A.S.).

Conus scalaris VALENCIENNES; Carmen Island, Loc. 828 (C.A.S.).

Crepidula sp.; Santa Antonita Point, Loc. 795 (C.A.S.).

Crucibulum imbricatum SOWERBY; Coronados Island, Loc. 796 (C.A.S.).

Crucibulum spinosum SOWERBY; Carmen Island, Locs. 798; 830 (C.A.S.).

Epitonium sp.; Santa Antonita Point, Loc. 795 (C.A.S.).

Fasciolaria princeps Sowerby; Santa Antonita Point, Loc. 795 (C.A.S.); Ceralbo Island, Loc. 840 (C.A.S.).

Fusinus dupetithouarsii Kiener; Santa Antonita Point, Loc. 795 (C.A.S.).

Fusinus sp.; Santa Antonita Point, Loc. 795 (C.A.S.).

Hipponyx antiquatus Linnaeus; Santa Antonita Point, Loc. 795 (C.A.S.).


Natica bifasciata Gray; Coronados Island, Loc. 796 (C.A.S.).

Nerita bernhardi Recluz; Ceralbo Island. Loc. 840 (C.A.S.).

Oliva spicata Bolten; Santa Antonita Point, Loc. 795 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 828 (C.A.S.); Las Galeras Island, Loc. 837 (C.A.S.).

Sthenorytis toroensis Dall; Monserrate Island, Loc. 835 (C.A.S.).

Strombus galeatus Sowerby; Santa Antonita Point, Loc. 795 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Locs. 798; 830 (C.A.S.); Ceralbo Island, Loc. 844 (C.A.S.).

Strombus granulatus Gray; Carmen Island, Locs. 798; 830 (C.A.S.).

Strombina maculosa Sowerby; Carmen Island, Loc. 828 (C.A.S.).

Terebra elata Hinds; Carmen Island, Loc. 828 (C.A.S.).

Terebra variegata Gray; Carmen Island, Loc. 828 (C.A.S.).

Trivia sanguinea Gray; Carmen Island, Loc. 828 (C.A.S.).

Turbo fluctuosus Wood; Carmen Island, Loc. 829 (C.A.S.).

Turbo saxosus Wood; Coronados Island, Locs. 796; 798; 830 (C.A.S.).

Turritella goniostoma Valenciennes; Santa Antonita Point, Loc. 795 (C.A.S.); Coronados Island, Loc. 796 (C.A.S.); Carmen Island, Loc. 828 (C.A.S.).

Cirripedia

Balanus sp.; Santa Antonita Point, Loc. 795 (C.A.S.).

Shark Teeth

Carcharodon cf. arnoldi Jordan; Santa Antonita Point, Loc. 795 (C.A.S.).
Collecting Stations with Faunal Lists and Field Notes

In the following list the age of each deposit is given with as much certainty as we could from a study of the fossils. These determinations, however, must be understood as being subject to change, in certain instances, when detailed stratigraphy and larger collections shall have been made. The numbers, with the exception of the first, are recorded in the locality register of the Department of Paleontology and the quotations from field notes are taken from the copy submitted by Dr. Baker immediately upon his return from the expedition.

Loc. 149 (L.S.J.U.) San Marcos Island; collection in Leland Stanford Junior University. A large deposit of gypsum on this island indicates a great change in topography of the present region occupied by the Gulf of California.

Pecten (Plagioctenium) circularis Sowerby.

Loc. 793 (C.A.S.) Marquer Bay, Carmen Island, Gulf of California; kitchen midden material; Fred Baker, coll.

Antigona multicostata Sowerby
Chama exogyra Conrad
Glycymeris gigantea Reeve

Ostrea fisheri Dall
Spondylus crassiquama Lamarck
Turbo fluctuosus Wood

Loc. 794 (C.A.S.) Arroyo de Arce, 15 miles north of Loreto, Lower California; Pliocene; "Cuesta Blanca". Fred Baker and Joseph Chamberlin, colls.; May 20, 1921; original location 1. See notes under No. 845.

Ostrea sp.
Ostrea megodon Hanley
Pecten bakeri Hanna & Hertlein, new species

Pecten circularis Sowerby
Pecten subnodosus Sowerby
Pecten stearnsii Dall

Loc. 795 (C.A.S.). One-half mile back from shore at Santa Antonita Point, Lower California. Fred Baker, Virgil Owen, Joseph Chamberlin, Joseph R. Slevin, and Ivan Johnston, colls.; May 16, 17, 1921; Pliocene.

Dr. Baker made the following notes on this locality: "The fossils were collected along a cañon about half a mile inland and which empties near the point. We found the beds delimit-
ed to the interior by a heavy deposit of red sandstone which seemed to dip from 15° to 40° in a south-southwesterly direction (magnetic) toward a saw-toothed ridge which terminates in a peak marked 1650 feet high on the chart. I conclude that the red sandstone underlies the fossil beds, cropping out in a northeasterly direction, circling round to a point south, or west of south of the cañon entrance. The dips apparently vary at different points, the whole country having been greatly displaced when it was elevated. These overlying fossil beds may be the beginning of the extensive deposits exposed near Loreto, 35 miles to the south. At places overlying the fossil beds were enormous numbers of shells of living species of mollusks and these appear to be of kitchen midden origin.” See Loc. 843.

*Clypeaster testudinalis* Gray
*Coral*
*Anomalocardia subimbricata* Sowerby
*Area pacifica* Sowerby
*Chama sp.*
*Chione succinta* Valenciennes
*Codakia colpoica* Dall
*Cyathodonta undulata* Conrad
*Macrocallista aurantiaca* Sowerby
*Ostrea megodon* Hanley
*Ostrea vestpentina* Conrad
*Ostrea sp.*
*Pecten bosei* Hanna & Hertlein
*Pecten carrizoensis* Arnold
*Pecten circularis* Sowerby
*Pecten dallasii* Jordan & Hertlein
*Pecten desertii* Conrad
*Pecten medenhalli* Arnold

Loc. 796 (C.A.S.) Coronados Island, Lower California; from southwest point of Island; V. Owen, coll.; Pliocene. Mr. Owen gave Dr. Baker the following notes of the discovery: “The whole southwesterly end of the island appears to be fossil-bearing, sedimentary rocks, the maximum exposed thickness being 40-50 feet. The layers lie flat or dip very slightly toward the southwest point of the island.”
Antigona multicostata Sowerby
Arca multicostata Sowerby
Cardium biangulatum Sowerby
Cardium consors Sowerby
Chama exogyra Conrad
Chione succincta Valenciennes
Codakia colpoica Dall
Glycymeris gigantea Reeve
Macrocysta squalida Sowerby
Margaritifera mazatlanica Hanley
Ostrea vespertina Conrad
Pecten cataractes Dall
Pecten subnodosus Sowerby
Spondylus crassispina Lamarck
Venerecardia crassicostata Sowerby
Cancellaria obesa Sowerby
Columbella fuscula Sowerby
Conus regularis Sowerby
Crucibulum imbricatum Sowerby
Natica bifasciata Gray
Oliva spicata Bolten
Strombus galeatus Sowerby
Turritella goniostoma Valenciennes
Turbo saxosus Wood

Loc. 797 (C.A.S.) East side of outlet of Arroyo de Gua into coastal plain 10 miles north of Loreto, Lower California; original No. 4, May 20, 1921; Fred Baker and J. C. Chamberlin, colls.; Pliocene. See under Loc. 845 for further notes about this locality.

Codakia colpoica Dall
Metis exuviaea Sowerby
Ostrea vespertina Conrad
Panope generosa Gould
Pecten circularis Sowerby

Loc. 798 (C.A.S.). (See under Loc. 830 C.A.S.)

Loc. 826a. Marquer Bay, Carmen Island, Gulf of California; Fred Baker, coll.; Pliocene. (See under 828 for field notes.) Three species only were found. The coral which formed an extensive reef has not been identified. The other two were:

Arca multicostata Sowerby
Pecten circularis Sowerby

Loc. 828 (C.A.S.) Marquer Bay, Carmen Island, Gulf of California; first location near south point of Bay; Pliocene.

Dr. Baker made the following notes on the occurrence of fossils at Marquer Bay: "There are at least five distinct exposures, all evidently the same layer as the yellow bluff exposed at Bellandra Bay and of identical character but they are not eroded above so that the entire formation is in evidence. The lowest exposed rocks are non-fossiliferous, hard, conglomerates followed by 40 to 50 feet of yellow sandy material, with a coral base and mixed with other classes of fossils, pec-
tens predominating. Above this, the layer of almost pure coral showing in large masses is overlaid by a darker layer, three to six feet thick containing little evidence of coral but a larger percentage of mollusks, chiefly pectens. One exposure is continuous for half a mile.

"Messrs. Johnston and Chamberlin crossed this island and reported a similar condition at the end of the next arroyo north of Arroyo Blanco, except that the strata contained a large number of species of small shells."

Encope grandis(?) Agassiz, specimens are smaller and more circular in form than the one from Cedros Island figured by Israelsky.

Coral
- Arca grandis Broderip & Sowerby
- Cardium biangulatum Sowerby
- Divaricella eburnea Reeve
- Kellia sp.
- Macrocystis squalida Sowerby
- Pecten cataractes Dall
- Pecten circularis Sowerby
- Phacoides lampros Dall
- Phacoides nuttalli Conrad

Actocinia angustior Baker & Hanna
- Arcularia complanata Powis
- Conus regularis Sowerby
- Conus scalaris Valenciennes
- Oliva spicata Bolten
- Strombina maculosa Sowerby
- Terebra elata Hinds
- Terebra variegata Gray
- Turritella gonioistoma Valenciennes
- Trivia sanguinea Gray

Loc. 829 (C.A.S.) On south side of Bellandra Bay, Carmen Island, Gulf of California, May 21, 1921; Fred Baker, coll.; kitchen midden material.

Antigona multicosata Sowerby
- Chama exogyra Conrad
- Ostrea fisheri Dall

Spondylus crassiquama Lamark
- Turbo fluctuosus Wood

Loc. 830 (C.A.S.) Locations 1 and 2 on south side of Bellandra Bay, Carmen Island, Gulf of California; Fred Baker, coll.; May 22, 1921; Pliocene.

Dr. Baker made the following notes on these localities: "I took fossils from two points (Loc. 1, 2) on the south side of the bay. No. 1 is below the notch beside the conspicuous conical peak. No. 2 is a yellow bluff which can be seen from Loreto and is about 200 yards east of No. 1. The outcrop at No. 1 is very limited but at No. 2 there is a rather remarkable ridge breaking off in a yellow bluff 40 feet high and 150 to 200 feet along the bay side. The upper part of this face is a

April 22, 1927
deep coral reef, the lower portion being made up largely of shells with some corals. Pectens are relatively scarce. The coral masses are very large, some of them measuring nearly a foot across at the base and 18 to 24 inches high. They are very soft and I was unable to secure satisfactory specimens but the shells are in very good condition indeed. On both sides of this yellow bluff are exposures of a porphyritic rock."


Dr. Baker was unable to collect any definitely identifiable fossils from this place but he made the following note regarding the occurrence: "Just at the end of the sand beach is a stratum of black rock extending from below water to about four feet above. It looked like vesicular volcanic rock but much to my surprise I found it containing a few fossils, Ostrea, Strombus, Pecten. The same layer seems to extend along the beach for a mile or more."

Loc. 835. Monserrate Island, Location 1, Gulf of California; Pliocene.

Pecten bosei Hanna & Hertlein  Sthenorytis toroönc Dall

Loc. 836 (C.A.S.) Monserrate Island, Gulf of California; Joseph R. Slevin, coll.; May 25, 1921; probably Pliocene. Mr. Slevin states that this exposure was found high up in the hills on the north end of the island and opposite Las Galeras Island.

Coral
Area multicostata Sowerby  Cassis coarctata Sowerby

Loc. 837 (C.A.S.) Las Galeras Island, Gulf of California; four miles north of Monserrate Island; Pliocene. The speci-
mens are preserved in a coarse sandstone poorly cemented with lime. Mr. J. C. Chamberlin who made the collection reported the island to be sedimentary and the upper layer containing extensive deposits of fossils.

*Arca multicostata* Sowerby

*Pecten circularis* Sowerby

*Oliva spicata* Bolten

Loc. 838 (C.A.S.) Pond Island. Float said to be from fossiliferous deposit but possibly in part from a kitchen midden; V. Owen, coll.; June 30, 1921; Pliocene, at least in part. The fossils were found back in the hills and were said to be abundant. It seems unlikely that there would be extensive kitchen midden deposits very far removed from the shore.

*Chione succincta* Valenciennes

*Ostrea vespertina* Conrad

Loc. 839 (C.A.S.) San Jose Island, Gulf of California; West Anchorage, Fred Baker, coll.; May 28, 1921; Pliocene. Mr. Slevin reports that the higher parts of this island contain extensive fossil deposits.

*Ostrea vespertina* Conrad

*Ostrea sp.*

*Pecten callidus* Hertlein

*Pecten circularis* Sowerby

*Pecten invalidus* Hanna

*Pecten stearnsii* Dall

*Spondylus crassiquama* Lamarck

Loc. 840 (C.A.S.) First and second anchorages, Ceralbo Island; Gulf of California, June 6, 7, 1921; Fred Baker, coll.; Pliocene.

Dr. Baker made the following field notes regarding the occurrence of fossils on this island: “The first anchorage was at a long sand beach extending to a point southeasterly and known locally as ‘Punta Arena’. South of this point are some yellowish sedimentary cliffs rising to a height of about 40 feet. There are several thin fossiliferous layers with coral predominating but I believe the entire formation contains some fossils.

“A few miles farther north the second anchorage was made in front of the Ruffo Ranch. On the north side of the ranch house cañon there is a conspicuous exposure of yellow fossilif-
erous sandstone. One upper layer which is blackened on exposure contains fossils in largest number. The strata are, in the main, horizontal but in one place they dip 30° possibly due to slippage."

Arca multicostata Sowerby
Margaritifera mazzallonica Hanley
Ostrea fisheri Dall
Fasciolaria princeps Sowerby

Loc. 841 (C.A.S.) Pelican Island, Gulf of California; May 5, 1921; kitchen midden material possibly; Fred Baker, coll.

Chione succineta Valenciennes.

Loc. 843 (C.A.S.) Santa Antonita Point, Lower California; kitchen midden (?) material, collected by Fred Baker, May 17, 1921.

The following well preserved species were found at this locality and since all are such as might be found suitable for food for Indians, the theory that the deposit is a kitchen midden is probably correct.

Arca receviana Orbigny
Chama pellucida Broderip
Dosinia ponderosa Gray
Ostrea fisheri Dall
Ostrea sp.

Pecten circularis Sowerby
Pecten subnodosus Sowerby
Tivela trigona Reeve
Fasciolaria princeps Sowerby
Turbo saxosus Wood

Loc. 844 (C.A.S.) Location 2, about 10½ miles north of Loreto, Lower California; in Arroyo de Gua; Pliocene. The shells were preserved in a hard, cemented, coarse sandstone with many fragments of the species recorded below. See under No. 845 for further notes about this locality.

Codakia colpoica Dall
Ostrea sp.

Pecten circularis Sowerby
Pecten subnodosus Sowerby

Dr. Baker made the following notes regarding the occurrence of fossils near Loreto. See also Nos. 794, 797, and 844.

"We rode about 15 miles nearly due north of Loreto, the first 10 miles being over the coastal plain. We then entered the Arroyo de Gua, a box cañon, and almost at once saw fossils on both sides.

"We rode about three miles up the Arroyo de Gua where we crossed a steep divide into Arroyo de Arce and finally climbed a very steep divide of white rock to get over a point in the bend of the arroyo. This mass of white rock nearly all contained fossils and is called 'Cuesta Blanca' locally. The Arroyo de Arce heads near this point and the road to Mulege passes over the divide and to the north.

"The last bit of road that I travelled, cut through a light yellowish bluff fully forty feet high and filled with fossils. To the west the bluff rose much higher and was topped by a thick layer of black rock dipping sharply (about 40°) to the north. This black rock is broken away at various places down the Arroyo de Arce and seems always to contain fossils.

"There seems to be much irregular turning of strata throughout the whole region in which cliffs 100 to 200 feet high are common. A short distance below Cuesta Blanca the strata were nearly level, followed further down by a strong southerly dip. A couple of miles south the layers rose and again dipped to the southeast near the end of the district. This indicated two anticlinal folds between Cuesta Blanca and my location 4 on the east side of the Arroyo de Gua at its exit to the coastal plain.

"We found it impossible to locate and follow definite strata about Cuesta Blanca and collected as of Loc. 1 (Loc. 794 C.A.S.) for about 200 yards down the narrowly washed out cañon.

"About four and a half miles down from Cuesta Blanca and in Arroyo de Gua we found a ledge dipping from the west side toward the trail; this ledge was densely packed with fossils, chiefly pectens. This was noted as Loc. 2 (Loc. 797 C.A.S.).

"Loc. 3 (Loc. 844 C.A.S.) was about one-fourth mile farther down the same side of Arroyo de Gua.
"Loc. 4 (Loc. 845 C.A.S.) was just at the outlet from Arroyo de Gua to the coastal plain. Here a fossil bearing ridge forms a bluff overhanging the trail and from this face a large block weighing not less than 30 tons had recently fallen, crushing one side when it struck. From this debris we picked a considerable number of fossils, the most striking being huge internal casts of Panope.

"Our guide told us that on a course more to the east and at a distance of about 25 miles, on the road to San Bruno, there were much more extensive and richer deposits of fossils. Apparently starting from the same ridge as the Cuesta Blanca and easterly from the Arroyo de Arce, a range of hills extends southeasterly to quite near the Gulf. It is sawtoothed, the highest peak being near the southerly end. The San Bruno deposits should be in, or just north of this range."

Correlation

A study of the foregoing faunal lists is conclusive that sediments of upper Pliocene age are present at various points along the Gulf coast of Lower California and on some of the islands in the Gulf. The collections numbered 793, 829 and 843 (C.A.S.), are thought to be Post-Pliocene in age. Whether any beds of lower Pliocene age occur along the east coast of the peninsula cannot be determined from the present collection. A large number of species in the present collection live at present in the Gulf of California, but the occurrence at many localities of species which have heretofore been known to occur only in the Pliocene at other places leads the writers to the conclusion that the age of the fauna as a whole is upper Pliocene.

Apparently the Gulf-Pliocene fauna is to be correlated most closely with the Pliocene of Maria Madre Island as previously stated by Jordan & Hertlein. The following species are common to the two: Terebratalia sp., Ostrea megodon Hanley, Ostrea vespertina Conrad, Pecten abietis Jordan & Hertlein, Pecten bakeri Hanna & Hertlein, Pecten circularis Sowerby, Pecten dallasi Jordan & Hertlein, Pecten invalidus Hanna, Pecten stearnsii Dall, Pecten subnodosus Sowerby.
Notes and Descriptions of Species

Clypeaster testudinarius (Gray)

*Clypeaster testudinarius* Gray, Mart. Wieg. Arch., 1, 1866, p. 170, "Timor".

The original description is as follows:

"Vent beneath, a little within edge, depressed; back slightly raised, evenly convex; under surface rather concave from the edge. *Hab.* Indian Ocean; Borneo."

A. Agassiz stated that the original reference to the occurrence of this species is erroneous. He listed it from Australia, Hawaii, Japan, Red Sea and Gulf of California.

Two specimens from Loc. 795 are referred to the species rather than *C. bowersi* Weaver\(^{15}\), from Coyote Mountain, Imperial County, California. The latter appears to be constantly larger and more ovate in outline although there is some doubt as to the distinctness of the two species in large series. *C. testudinarius* has been considered to be the living form of the Gulf of California.

**Pecten (Patinopecten) bakeri** Hanna & Hertlein, new species

Plate 5, figure 1

Left valve, large, subcircular, moderately convex, moderately thick; about 23 to 25 radiating square sided ribs separated by interspaces a little wider than the ribs, each rib ornamented with three small riblets, one on each shoulder and a middle riblet which is a little higher than the other two riblets; interspaces ornamented by three small riblets, the middle one usually slightly more prominent than the other two; ribs and

\(^{15}\) See Kew, Univ. Calif. Publ. Geol., Vol. 12, No. 2, 1920, p. 58, pl. 5, figs. 1a, 1b, pl. 6, fig. 1.
interspaces both covered by fine, fairly sharp concentric lines of growth; ears subequal, set off from beak by sharp squarish shoulders, ornamented by about eight or nine radiating riblets which are crossed by concentric incremental lines. Length approximately 150 mm.; height approximately 132 mm.; apical angle approximately 123°.

Holotype: left valve No. 1865, from Loc. 794 (C.A.S.) “Cuesta Blanca” on Arroyo de Arce, 15 miles north of Loreto, Lower California; paratype: left valve, No. 2214, same locality; Fred Baker, collector; upper Pliocene.

_Pecten bakeri_ differs from other patinopectens by the number and arrangement of the secondary ribs, which ornament the ribs and interspaces.

This fine species is named for Dr. Fred Baker of San Diego, California, who collected the type specimen; it is one of the most striking pectens discovered in western North America in many years.

Fragments of a pecten in the collection from Loc. 937 (C.A.S.) on Maria Madre Island, which were collected by Hanna & Jordan, apparently belong to this species.

_Pecten (Pecten) bösei_ Hanna & Hertlein, new species

Plate 5, figures 2, 3

Shell fairly large; right valve convex, ornamented by about 24 to 25 rather low, flattish-topped ribs which seldom show sulcation; interspaces narrower than ribs, flattish but slightly rounded at edges; ribs and interspaces crossed by fine concentric incremental lines; ears fairly large, subequal; anterior shows a faint byssal notch, above which the anterior ear slopes to hinge line forming an oblique angle; this ear possesses a fold near base; posterior ear slopes fairly abruptly to shell; ears set off from shell by sharp line and both ears ornamented by fine incremental lines of growth. Left valve slightly convex, ornamented by about 24 to 25 radiating, rounded ribs and
interspaces, crossed by fine concentric incremental lines; ears slope from hinge line obliquely toward margin of shell. Length of right valve 74 mm.; height, 66 mm.; apical angle, approximately 100°; hinge length, 28 mm.

**Syntypes**: right valve, No. 2215 and left valve No. 2216, from Loc. 795 (C.A.S.); **cañon about half a mile inland from Santa Antonita Point, Lower California. Paratypes**: Nos. 2217; 2218; 2219; 2220; 2221 (C.A.S.) from same locality; Fred Baker, collector; upper Pliocene.

This species differs from *P. stearnsii* Dall and *P. diegensis* Dall in possessing much lower ribs and these are usually broader and seldom show sulcation.

This species is named for Dr. Emil Böse in recognition of his contributions to the Geology of Lower California.
Fig. 1. *Pecten bakeri* Hanna & Hertlein, new species. *Holotype;* No. 1865, from Loc. 794 (C.A.S.) "Cuesta Blanca" on Arroyo de Arce, 15 miles north of Loreto, Lower California; length about 150 mm.; p. 153.

Fig. 2. *Pecten bosei* Hanna & Hertlein new species. *Syntype;* No. 2215, from Loc. 795 (C.A.S.) about one half mile inland from Santa Antonita Point, Lower California; length, 74 mm.; p. 154.

Fig. 3. *Pecten bosei* Hanna & Hertlein new species. *Syntype;* No. 2216, from Loc. 795 (C.A.S.) about one half mile inland from Santa Antonita Point, Lower California; length, 80 mm.; p. 154.
EXpedition to Guadalupe Island, Mexico, in 1922

Land and Freshwater Mollusks

By

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The exploration of Guadalupe Island was the chief object of the Expedition of the California Academy of Sciences in 1922, but collections were also made at San Quintin Bay, San Martin Island, Cedros Island, the San Benito Islands, Natividad Island, Asuncion Island, Turtle Bay, and Margarita Island and other places around Magdalena Bay. In the following report the mollusks of Guadalupe Island are considered separately from those of the west coast of Lower California and adjacent islands.

I am indebted to Dr. G. Dallas Hanna, in charge of the expedition, and to Dr. Barton Warren Evermann, Director of the Museum, for the opportunity of working up the land and freshwater mollusks collected.

1 This is paper No. 5 of the Tecate Expedition. No. 1, the General Report, gives a complete itinerary. See Vol. XIV, No. 12, pages 217-275, of these Proceedings.

April 22, 1927
Guadalupe Island

Guadalupe Island lies 135 miles southwesterly from Point San Antonio, Lower California. It is about 22 miles long, three to six miles wide, and in the northern part rises to an elevation of 4500 feet. There is deep water on all sides; between island and mainland there is a trough over 2000 fathoms in depth. Four miles north of the island, a depth of 1400 fathoms has been found, and about the same distance south over 1100 fathoms. "The summit of Guadalupe is the crest of a gigantic mountain ridge rising over 16,500 feet above its level base on the sea bottom, with only a little more than one-quarter of its height appearing above the surface of the sea."³

The visible structure is volcanic. A large part of the island is arid, but the higher ridges extend into the zone of lower clouds. "Owing to its situation in the midst of cool ocean currents and the prevalence of northwesterly winds, it is much cooler than any part of the coast of Lower California at the same altitude."³ There is considerable frost and cold rain in winter.

The flora and fauna of Guadalupe are rapidly disappearing owing to the introduction of goats, of which there are thousands, and of house mice and cats.

The origin of the Guadalupe fauna and flora is obscure. The land molluscan fauna is not related to that of Lower California and its islands. Its affinities are with the lower group of Channel Islands of California—Santa Barbara, Santa Catalina, San Nicolas and San Clemente islands, and in a smaller degree with the Californian mainland. The details of relationship will be discussed in the descriptive part of the paper. About 78 per cent of the species and subspecies are endemic. The flora, also, is said to be more nearly related to that of California than to the Lower Californian; at least 29 out of 145 species of plants are endemic.


³ E. W. Nelson, loc. cit.
The direction of the ocean current is favorable for the transport of drift materials from the Channel Islands and Californian coast to Guadalupe; yet at the present time such drift as originates in the Californian islands must be very small stuff. Living snails would have little chance of surviving the voyage to Guadalupe, one would think, and less of making a landfall in a place where land snails could survive. Xerarionta, now the dominant snail of the Channel Islands, living on and under bushes and cacti, is lacking on Guadalupe, where all the species appear to be ground snails. There remains the hypothesis that the submarine ridge upon which Guadalupe stands is what remains of a sunken or down-faulted late tertiary peninsula similar to the present peninsula of Lower California, in which case the resemblance of the fauna and flora would be due to former continuity of land. A weighty objection to this hypothesis is the great depth of water over the Guadalupe ridge. Whether this submarine ridge extends to California, I do not know.

Eleven of the 14 species and subspecies of land mollusks known are special to Guadalupe. Grouped by the affinities of the species elsewhere, they fall into three categories, thus:

1. Species either occurring on the California Channel Islands, or most nearly related to species or subspecies only found there; (six genera, eight species).

   *Micrarionta guadalupiana*  
   *Haplotrema guadalupensis*  
   *Binneya guadalupensis*  
   *Succinea guadalupensis*  
   *Vertigo californica catalinaria*  
   *Vertigo californica guadalupensis*  
   *Vertigo degeneris*  
   *Sterkia clementina*  

2. Species most nearly related to those of the Californian mainland; (two genera, two species).

   *Helminthoglypta hannai*  
   *Striatura milium pugetensis*  
   *Helminthoglypta h. diodon*  

3. Species most nearly related to those of the northern coast (San Quintin Bay region in the San Diegan faunal area) of Lower California; (one genus, two species).

   *Pupilla goniodon.*  
   *Pupilla guadalupensis*  

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*Probably identical with a common fossil Succinea of San Clemente Island.
*Identical with a Santa Catalina Island form.
*Identical with a San Clemente form.
*Found on the mainland from San Diego Co., Calif., to Vancouver Island.*
Truncatella guadalupensis does not appear more closely related to west coast species than to West Indian. Its nearest affinities are not obvious.

The history of the Guadalupe mollusk fauna goes back about 50 years. The first snails appear to have been collected by Dr. Edward Palmer in 1875. In 1878 W. G. Binney reported the occurrence of Binneya notabilis, and in the following year recorded Palmer’s other mollusks, Arionta rowelli Newc. and Arionta facta Newc. He discussed Binneya again, and concluded that the fauna was of Mexican origin.

An unsigned note in Science, 1884, mentioned the finding of Helix facta and Binneya notabilis by R. G. Dunn, noting the peculiar epiphragm or “hybernaculum” of the latter, and concluded quite correctly that “the fauna and flora of this isolated island are largely southern Californian rather than Mexican.”

In 1887 J. G. Cooper commented on the collections of Dunn and others thus: “On Guadalupe Island Mr. W. E. Bryant found a form more like that of the Lower Californian peninsula, once confounded with H. remondi. Mr. R. G. Dunn informs me that H. facta is also found on Guadalupe Island, and the very peculiar helicoid Binneya notabilis has been found there by Mr. Bryant, as well as on the peninsula by Mr. Orcutt.”

W. H. Dall, in 1900, described EpipHragmophora guadelupiana and Succinea (rusticana var.?) guadelupensis. The former obviously is the snail previously called “H. facta.”

H. A. Pilsbry, 1901, described a species of Truncatella collected by R. E. Snodgrass.

The earlier authors identified Guadalupe snails with species of the Californian islands and mainland, which they certainly

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*The references are as follows:


Anonymous note on shells collected by R. G. Dunn, Science, Vol. 4, No. 88, Oct. 10, 1884, p. 366. (R. G. Dunn was a collector of seeds who lived in San Francisco to the advanced age of about ninety years. He was considered eccentric, as he apparently preferred gathering seeds to chasing dollars.)


H. A. Pilsbry: Nautilus, XV, 1901, p. 83.
resemble. It cannot be doubted that further exploration of Guadalupe will increase the number of species, although it seems that several are generally distributed over the island.

**Helicidæ**

1. **Micrarionta guadalupiana** (Dall)

Plate 8, figures 1, 1a, 3, 3a, 3b; text fig. 1


Guadalupe Island (Anthony; Snodgrass and Heller). Northeast Anchorage and three miles south of same; Pine Ridge, northwest end of the island, at about 3000 feet elevation; east side two miles north of the South Point (G. D. Hanna).

Fig. 1. *Micrarionta guadalupiana* (Dall). Plesiotypes, Nos. 2557-2559 (C.A.S. Coll.), from three miles south of Northeast Anchorage, Guadalupe Island, Lower California.

This small species, with subcircular, white-lipped aperture appears to be common. The largest shells are from 3 miles south of the Northeast Anchorage, and measure 11.3 to 12.6 mm. diameter. Many of this lot have the spire well elevated and the peripheral angulation weak or subobsolete. Nearly as large ones were taken at Pine Ridge. The lot from Northeast Anchorage, 8 to 10.5 mm. diameter, run smallest and are most distinctly angular.

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* The name of this species was originally spelled *guadelupiana*. It appears allowable to emend the name to conform to the recognized orthography of the name of the island, Guadalupe.

In 1898 I published some anatomical details of *E. guadalupiana* from a specimen sent me by Dall for that purpose, not noticing that the species was undescribed at that time. As no details of the shell were given, my premature use of the name should not affect nomenclature.
In Proc. A. N. S. Phila. 1898, p. 68, pl. 1, fig. 11, I described and figured the genitalia of one of the original specimens sent by Dall. As the figure was too small to show the structure plainly, a new one, drawn from the same preparation is given, plate 8, figs. 3, 3a (upper part of the female system omitted). The capacious penis passes into a large epiphallus which is continued in a spirally coiled flagellum. The uterus is a very capacious thin-walled sac, the walls longitudinally ridged internally, fig. 3a. There is no dart sac visible either outside or within, merely a curved whitish ridge of the integument at the bases of the mucus glands. Both of these are free, as shown in the figure, the descending one club-shaped with rounded end.

The foot, mantle and genitalia are pale chamois-colored. In my original account I stated that the right ocular retractor passed to the left of the genital system; this appears improbable, and may have been an error of observation, but it can not now be confirmed or denied, as the reproductive organs were removed from their place. Length of penis and epiphallus 9 mm., of flagellum 10 mm., of spermatheca and duct 15 mm.

The jaw of this specimen, Pl. 8, fig. 3b, has 8 ribs.

In two specimens dissected from near Northeast Anchorage I find the structure different. The foot is dusky on the back, paler on the sides and tail; mantle more or less closely maculate with black. The right ocular retractor passes between penis and female organs as usual. Genitalia, Pl. 8, figs. 1, 1a. The penis is costate within and separated from the epiphallus by a perforated partition. Epiphallus about as large as the penis, bearing the retractor muscle, its upper part twisted spirally. The flagellum tapers rapidly and is about equal to the penis and epiphallus in length. The female side bears a well developed dart sac, in the crotch of which the two mucus gland ducts are inserted. The ascending gland (a.m.g.) is long, bulbous at the end, and lies free. The descending gland (d.m.g.) terminates in a thin, broad collar encircling the entire penis. The spermatheca is ovate, on a long branchless duct of large caliber.

Length of penis 3 mm.; epiphallus 3.7 mm.; flagellum 6.5 mm. Spermatheca and duct 9 mm. Specimen not killed extended, preserved in alcohol.
In all essential characters this system agrees with that of *M. facta* (Newc.) of Santa Barbara Island, but differs remarkably from that of the paratype of *M. guadalupiana* which I dissected. The specimens of *M. guadalupiana* from Northeast Anchorage had been preserved in alcohol without drowning, and the greater contraction may account for the smaller size of the organs. But the differences in the dart apparatus are not so easily explained. It appears unlikely that there are two species practically alike in shell characters but differing in genitalia, and for the present I incline to the theory that the organs of the paratype of *guadalupiana* which I examined are not mature, or were abnormal. Unfortunately, only three adult examples, from a single station, were preserved in spirit by the 1922 expedition.

For comparison with *M. guadalupiana*, I figure the genitalia of *M. facta* (Newc.), (plate 8, fig. 2, from Santa Barbara Island, No. 99246 A. N. S. P., coll. by H. N. Lowe, July, 1909. The whole animal, when removed from the shell, is chamois-colored, except that there are a few gray spots on the thin lining of the early whorls. The arrangement of mucus glands is exactly as in *M. guadalupiana* from Northeast Anchorage, the ascending one free, the descending spreading in a thin wide collar around the penis. The epiphallus and flagellum are spirally coiled. The right ocular retractor passes between the branches of the genitalia.

2. *Helminthoglypta hannai* Pilsbry, new species

Plate 7, figures 8, 9, 9a, 9b; text figure 2

Shell umbilicate, the width of umbilicus contained about seven times in diameter of shell; depressed, with rounded periphery and low, conoidal spire (or sometimes it is very little raised above the level of the last whorl); dull citrine to olive-lake, with paler streaks and a rather indistinct dusky band above the periphery; the inner whorls having lost the perios-tracum by wear are walnut brown to burnt umber. The surface is glossy, the early whorls showing fine granulation where

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10 I may mention that I opened a single *M. gabbi* (Newc.) from near Avalon, Santa Catalina, and found the mucus glands as in the paratype of *M. guadalupiana*. The shell was apparently adult; but until more material can be dissected, I do not feel that definite conclusions can be reached.
unworn; on the last whorl this becomes almost effaced (though minute granules may be seen in some places) and it is lightly striate along growth lines. The whorls are moderately convex, the last descending a little in front, rounded basally. The oblique aperture is nearly circular but somewhat wider than high. Peristome thin, narrowly expanded throughout, of a very pale brownish-pink tint, the margins converging, connected by a thin, transparent callus.

Height 13 mm.; diam. 20.6 mm.; 5½ whorls. (Holotype.)
Height 9 mm.; diam. 17.0 mm.; 5 whorls. (Paratype.)


Two fresh young examples show the sculpture of the embryonic and early neanic whorls. The embryonic shell appears to consist of nearly two whorls, but its limit is not definitely marked. In the youngest example it is densely papillose, the papillae closely strewn, not in any pattern; towards the end of the first whorl there are some short bristles scattered among the papillae, these continuing upon the early neanic whorls. In an older individual of about 3½ whorls the papillae are crescent in some places into smooth radial wrinkles; short bristles appear among them at and beyond the end of the second whorl.

The animal is dark gray to slate color, fading to pale buffy-gray on the tail; coarsely granose.

The right ocular retractor runs between penis and oviduct. The penis is short (3 mm. long), about one-fourth as long as the epiphallus, in the middle of which the very long retractor is inserted. The flagellum is about 6 mm. long. The duct of the spermatheca and its diverticulum are very long (not preserved entire, the animal having been broken in pulling). There is a large dart sac with longitudinally corrugated internal walls. Mucus glands unequal, with reflected ends, both discharging through a single slender duct.

The kidney is 8½ mm. long, pericardium 5 mm. long.
This is doubtless the species mentioned without name by Cooper in 1887, and as *Epiphragmophora sp. indet.* by Dall, Proc. A. N. S. Phila., 1900, p. 102; a single young shell was collected by A. W. Anthony in 1896. Presumably it was this species or the following race which Binney called *Arionta rowelli*, and Cooper referred to as like a peninsular species "once confounded with *H. remondi*.”

The light greenish glossy shell with a very faint band and a narrow lip is characteristic and quite unlike any known species of the region. The coloration resembles that of some Californian Helminthoglyptas, and the reproductive system conforms wholly to that genus, the mucus glands branching from a single duct which enters high on the dart sac. In *Microarionta* the two mucus glands excrete through separate ducts entering in the crotch between dart sac and vagina.

3. **Helminthoglypta hannai diodon** Pilsbry, new subspecies

Plate 10, figures 23, 24, 25, 26

The shell is similar to *H. hannai* in form and in sculpture so far as this is preserved, the intermediate whorls showing some minute granulation. On the parietal wall a short distance within its limit there are two low oblong callous nodules, their longer axes converging forward at approximately somewhat more than a right angle, but usually not meeting; the
inner nodule stands close to or united with the columella, the outer one being near the suture.

Height 13.0 mm.; diam. 21.5 mm.; 5½ whorls. (Holotype.)
Height 11.4 mm.; diam. 20.0 mm.; 5½ whorls.

The largest and smallest adult shells have diameters of 22 and 17.5 mm.


The nodules of the parietal wall are shaped and situated exactly as in *Sonorella dalli* Bartsch and *S. parva* Pils. Elsewhere, somewhat similar “teeth” occur in the Chinese group *Metodontia*.

In a few individuals the two nodules are weakly connected, forming a bow, thus ( ; and in a few others they are obsolete in apparently mature or nearly mature shells. Although considerable search was made for living snails, only old dead shells were found.

**Haplotrematidæ**

4. **Haplotrema guadalupensis** Pilsbry, new species

Plate 7, figures 7, 7a

The shell resembles *Haplotrema catalinensis* (Hemphill), being small, depressed, whitish, with, on the last whorl retractively radial, low and weak striae, locally distinct but mainly more or less effaced; differing from that species by the smaller size with rounder, less depressed whorls and a cordate aperture less excised by the preceding whorl and nearly as high as wide; (in *H. catalinensis* the aperture is much wider than high). The umbilicus is very broadly open. The lip is thin but smoothly finished, the upper margin slightly straightened.

Height 2.25 mm.; diam. 4.9 mm.; width of umbilicus 1.8 mm.; 3½ whorls. (Holotype.) Height 2 mm.; diam. 4.7 mm. (Paratype.)

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This species belongs to the typical group of Haplotrema, the large continental species forming the new subgenus Geomene, type, Helix concava Say.

Zonitidae

5. Striatura milium pugetensis (Dall)

Patulastra? (Punctum?) pugetensis Dall, Nautilus, VIII, 1895, p. 130.

In this form the initial whorl shows strong spiral striation. Described from near Seattle, Washington, it has since been found in several places on Vancouver Island (C. Montague Cooke, A. W. Hanham), in Oregon (John A. Allen), in the San Bernardino Mountains, San Bernardino Co., California (S. S. Berry), and in San Diego Co. at Ballena (Hemphill) and the Palomar Mountains (Joshua L. Baily, Jr.). It appears to be widely spread on the Pacific slope, and will doubtless be found in many places when leaf-sifting becomes more general.

The Guadalupe Island specimens are entirely similar to those of California. They were found in the hills about 1000 feet above Northeast Anchorage and on the east side of the island about two miles north of the south end; G. D. Hanna, coll.

Arionidae

6. Binneya guadalupensis Pilsbry, new species

Plate 6, figures 2-9; plate 9, figures 2, 2a, 2b, 2c, 2d, 3

Binneya notabilis of the Guadalupe lists of Binney, Cooper and others.

The shell is more convex than B. notabilis, the convexity one-third of the length; on the ventral side there appears a larger crescent of the latero-basal wall; the furrows between spiral cords of the first whorl are transversely costulate, and the adjacent part of the post-embryonic whorl is rather sharply striate along the lines of growth.

Length 9.5 mm.; width 6.6 mm.; convexity 3.2 mm.
Length 12 mm.; convexity 4.1 mm.

This is doubtless the snail which has repeatedly been reported from Guadalupe as Binneya notabilis. Comparison with a good series of B. notabilis from Santa Barbara Island shows that the Guadalupe form is quite distinct specifically by characters of shell, genitalia and, less significantly, of jaw. It seems to be abundant, generally spread over the island and cruelly preyed upon by the feral house mouse.\(^{13}\)

A drowned individual dissected has a foot length of 20 mm., mantle length 11 mm. The pedal furrow is well impressed, and there is an irregular, impressed line above it. Spaced grooves radiate from the mantle, connected by sparse reticulation. The mantle is quite narrowly reflected over the edges of the shell, and is produced in a broad body-lobe in front; buff, maculate with black. Pneumostome large, behind the middle. The body is pale buff, maculate with dark gray, the maculae more or less noticeably arranged in radial order, wanting on the tail, the face and back gray, not maculate. The tail is concave below the back of the shell, elsewhere rounded above. The sole is pale buff, distinctly tripartite by impressed lines. Alcoholic specimens are figured, Pl. 6, figs. 7, 8, 9.

Genitalia, Pl. 9, figs. 2-2d. The genital orifice is below and behind the right ocular tentacle, the retractor muscle of which passes between penis and oviduct. The penis is well developed, with terminal retractor inserted on the diaphragm and arises a short distance from the end of penis. The epiphallus is much longer than the latter. There is an enormous atrium plus vagina, its thin walls corrugated internally in places. When cut open, as in Pl. 9, fig. 2b, it is found to contain a large conic body 9 mm. long, one side of which forms a compressed wing which coils partly around the main body, as in figs. 2b, 2c. The wing is wanting in the distal third. It is composed of a cylindric cone of hard circular muscles, surrounded by a layer of spongy tissue, which is minutely, closely and superficially fissured externally in a circular direction. It is perforated by the oviduct, the perforation stelliform in sec-

The spermatheca is irregularly ovate on a rather short duct which enters about at the upper third of the atrial sac.

The jaw, Pl. 9, fig. 3, has eight strong ribs projecting slightly at the margins, the ends free from ribs.

The genitalia of this species differ widely from Binney’s description and figure of those organs in *Binneya notabilis*, but I have not been able to obtain that species in the flesh for direct comparison. There is no reason to believe that Binney’s figure is far wrong, but the Santa Barbara Island species ought to be dissected again to confirm its characters, and especially to determine the internal structure of the lower ducts of the female side, which Binney did not open.

The external characters of the animal are about the same in the two species, also the general character of the jaw (8-ribbed in *B. guadalupensis*, 6-ribbed in *B. notabilis*) and the peculiarly extended papery epiphragm, shown in Pl. 6, figs. 3, 6.

W. G. Binney\(^{15}\) expressed the opinion that the Mexican genus *Xanthonyx* was identical with *Binneya*. At one time I accepted this synonymy,\(^{16}\) but subsequently\(^{17}\) the relationship of *Xanthonyx* to the Helicidæ was recognized. It has nothing to do with Binneya. *Binneya* is not a “Mexican genus” as stated by Binney. It is known from Santa Barbara and Guadalupe islands only.

**Succineidæ**

7. **Succinea guadalupensis** Dall

*Succinea (rusticana Gld. var.?) guadalupensis* Dall,\(^{15}\) Proc. A. N. S. Phila. 1900, p. 102, pl. 8, fig. 12.

Only a fragment obtained; Guadalupe Island: Pine Ridge, about 3000 feet elevation (G. D. Hanna). This form appears indistinguishable from shells of San Clemente and San Nicolas.

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\(^{14}\) This large muscular terminal part of the oviduct may possibly function as an organ of copulation, analogous to the condition existing in some other Arionidæ, but in the absence of a retractor muscle this is doubtful.


\(^{16}\) Proc. A. N. S. Phila, 1898, p. 229.


\(^{18}\) As in the case of *Micrarionta guadalupiana*, I emend the name “guadalupensis.” To perpetuate an inadvertent wrong spelling of a geographic unit which has never had but one orthography seems to me pedantic, although in general I adhere to the original spelling of a specific name.
islands which generally have gone under the name *S. azara* Say. It is a very difficult group; and while I doubt whether the Guadalupe Island form is a distinct species, not much can be said until fresh shells come to hand.

**Pupillidæ**

8. *Pupilla goniodon* Pilsbry, new species

Plate 7, figure 3

The shell resembles *P. sterkiana* of the Lower Californian mainland in shape and sculpture. It is thin, cylindric, with blunt, rounded ends, cinnamon colored, with sculpture of strongly retractive, widely spaced riblets, which are more or less irregular or in places dislocated, sometimes with short, twig-like branches; they are about one-fourth as wide as their intervals or less. The initial 1½ whorls have irregularly anastomosing net-like sculpture and pale grayish color. Subsequent whorls are moderately convex, and the last one rises somewhat and becomes flattened laterally towards the aperture. The aperture is about as wide as long, somewhat squarish with rounded angles. The peristome is expanded, the outer and basal margins thickened with a cinnamon callus within, upper external margin thin; columellar margin dilated. There is a transverse white nodule on the parietal wall within the angle of the lip, united with the latter, and continued in a thin callus across to the columellar lip-insertion. Length, 4 mm.; diam., 1.9 mm.; 6¾ whorls.

*Holotype:* No. 2574, Mus. Calif. Acad. Sci., from **Northeast Anchorage, Guadalupe Island, Lower California**; collected by G. D. Hanna at an elevation not greater than 100 feet, in the cañon back of the buildings; abundant.

The presence of a strong angular nodule and the more delicate riblets differentiate this species from *P. sterkiana*. In exceptional specimens there is the barely perceptible trace of a parietal tooth, rather deep within; in none do I see any columellar tooth or truncation, such as *P. sterkiana* usually shows in an oblique view in the aperture. The species was collected alive in some numbers.
9. **Pupilla guadalupensis** Pilsbry, new species

Plate 7, figures 1, 2

Shell cylindroid, slowly tapering in the upper half, cinnamon colored, only slightly glossy, very evenly sculptured with retractive riblets paler than the ground color, from a half to a third as wide as their intervals and about 14 to 16 in one millimeter on the face of the last and penult whorls; the usually paler 1½ embryonic whorls have the net-pitted sculpture of Striopupilla. Subsequent whorls are rather strongly convex. Aperture rounded below, straightened with rounded angles above; no trace of a crest or contraction behind outer lip. Peristome expanded, heavily thickened within except at the posterior-lateral curve, continuous in a slightly free or adnate callus across the parietal wall. Aperture typically four-toothed: angular lamella in form of a callous pad within the posterior angle, parietal lamella short, stout, deeply placed, columellar lamella low and broad, palatal fold a rounded, deeply placed tubercle. (Other forms of the species may lack all but the angular pad.)

Length 2.8 mm.; diam. 1.5 mm.; 5½ whorls. (Holotype.)
Length 3.1 mm.; diam. 1.5 mm.; 5¾ whorls.

**Holotype**: No. 2575, *paratypes* Nos. 2576-2578, Mus. Calif. Acad. Sci., from Guadalupe Island, Lower California, 1000 feet above Northeast Anchorage; *paratypes*: Nos. 2579-2580 from two miles north of south end of island on east side; G. D. Hanna, Coll. The species was also found near sea level at Northeast Anchorage and on the crest of Pine Ridge at an elevation of 3000 feet.

The close, regular, evenly developed ribs distinguish this species from other American Pupillæ, the other two species of the subgenus Striopupilla having the ribs more uneven and more widely spaced. It resembles the Asiatic *Pupilla annandalei*, which, however, belongs to a different subgenus.

As in most species of this genus, the parietal, columellar and especially the palatal teeth are variable, either present or absent. The angular pad appears in all adult individuals, and is sometimes the only tooth present, as in fig. 2. The four-toothed form, selected as typical on account of its status as the
most primitive form, is exceptional in some lots seen, but common in other lots.

Five specimens taken at random from the type lot have teeth as follows:

1. Angular, parietal, columellar, palatal.
2. Angular, parietal, columellar, palatal.
3. Angular, parietal, ..................
4. Angular, ........ columellar, ........
5. Angular, .........................

In No. 2 the parietal is very small; in No. 4 the columellar can be seen only in an oblique view in the aperture.

A similarly unselected lot of ten, from two miles north of the south end of the island, has teeth as follows:

1. Angular, parietal, columellar, palatal.
2. Angular, parietal, columellar, palatal.
3. Angular, parietal, columellar, palatal. 10
4. Angular, ........ columellar, palatal.
5. Angular, parietal, columellar, ........
6. Angular, parietal, columellar, ........
7. Angular, parietal 10 columellar, ........
8. Angular, parietal, ........ palatal.
9. Angular, parietal, ..................
10. Angular, ........................

10. **Vertigo californica catalinaria** (Sterki)

Plate 7, figure 5

Man. Conch. XXV, 1919, p. 142, pl. 9, figs. 5, 6.

The specimens are darker than the Catalina Island form, but no other difference was detected. There is some variation in diameter among them, also in the spacing of the ribs, the specimen figured having them more widely spaced than some others. Very few are fresh, most being dead shells, so fragile that they cannot be cleaned. Length 1.95 mm.; diam. 1 mm. The species was found generally distributed by Dr. Hanna: At Northeast Anchorage and 1000 feet above; and two miles north of the south end on the east side.

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10 This tooth is very small.
11. *Vertigo californica guadalupensis* Pilsbry, new subspecies

Plate 7, figure 4

The differential characters of this form are that it possesses a distinctly developed angular lamella standing about midway of the length of the long parietal lamella, and the striaion is quite fine, there being about 30 striae in 1 mm. on the face of the last whorl. Length 2 mm.; diam. 1.1 mm.

_Holotype:_ No. 2582, Mus. Calif. Acad. Sci., from Guadalupe Island, Lower California; collected about 1000 feet above the landing at Northeast Anchorage by G. D. Hanna.

In most groups of *Vertigo* the presence or absence of an angular lamella has little significance, but in the *V. californica* group I have never seen this lamella in hundreds of shells examined. However, Dr. V. Sterki has mentioned seeing “traces” of an angular lamella in some specimens of *V. californica*, which is a larger, more coarsely sculptured form than *V. c. guadalupensis*. I have thought it best to name this island form in order to stimulate the attention of future collectors. It was found associated with *V. c. catalinaria*.

12. *Vertigo degeneris* Pilsbry, new species

Plate 7, figure 6

The oblong, brown shell tapers from the last whorl to the obtuse apex. The whorls are strongly convex, _almost smooth_, but on the penult whorl some spaced wrinkles along growth lines are noticeable; though weak, they evidently correspond to the riblets of *V. californica*. The rounded aperture has no teeth. Columella concave, the columellar lip being rather broadly expanded. Length 1.9 mm.; diam. 1.1 mm.; 4½ whorls.

_Holotype:_ No. 2583, _paratypes_ Nos. 2584, 2585, Mus. Calif. Acad. Sci., from Guadalupe Island, Lower California; collected about 1000 feet above the landing at Northeast Anchorage by G. D. Hanna.

A strongly characterized form, which, however, may prove to be connected with a similarly toothless form found at Northeast Anchorage, in which the riblets are well developed. _April 22, 1927_
Length 1.8 mm.; diam. 1.1 mm. As only broken examples of this ribbed form were taken, its status is left in suspense for the present.

13. **Sterkia clementina** (Sterki)

Man. Conch. XXVI, p. 54, pl. 7, figs. 9, 10, 13.

A single specimen taken at Northeast Anchorage, Guadalupe Island (G. D. Hanna), in which the whorls are a trifle less convex than in a San Clemente cotype, but the difference is so small that no separation of the forms appears feasible.

**TRUNCATELLIDÆ**

14. **Truncatella guadalupensis** Pilsbry

Plate 7, figure 11

*Truncatella stimpsoni guadalupensis* PILSBRY, Nautilus XV, Nov., 1901, p. 83.

The subcylindrical shell tapers slowly to the truncate summit and is pinkish-cinnamon colored on the last whorl, fading on those above. The whorls are rather weakly convex, the suture not deeply impressed. Sculpture of moderately strong vertical ribs, weaker or partially effaced on the convexity of the last whorl. There is a strong, rounded rib or crest close behind the outer and basal lip margins. The aperture is ovate, the lip expanding a little. Length 6.5 mm.; diam. including outer lip 2.6 mm.; above aperture 2.5 mm.; 4½ whorls.

Guadalupe Island: Type and paratype No. 81973 A. N. S. P., collected by R. E. Snodgrass, November, 1899.

I formerly ranked this form as a subspecies of *T. stimpsoni* Stearns, but having compared long series of all the west coast species, *T. californica* Pfr., *T. stimpsoni* Stearns and *T. bairdiana* C. B. Ad., I consider the Guadalupe form quite distinct, not closely related to any of them. It is stouter in figure than *T. stimpsoni* figured for comparison in Pl. 7, figs. 10, 12-14; the sutural region is not excavated as in that species; the ribs are not so prominent, and in a face view the last whorl is seen to be longer relative to the length of the shell, occupying more
than half of the total length, while in T. stimpsoni it is decidedly less.
This species was not obtained by the expedition of 1922. Just where on the coast Mr. Snodgrass picked it up was not recorded.

LOWER CALIFORNIAN WEST COAST AND ADJACENT ISLANDS
HELICIDÆ

All of the Lower Californian Helicidæ appear to belong to the genus Micrarionta. The capacious coastal and insular species form the subgenus Xerarionta. The depressed, smoothish, umbilicate forms, largely of the interior, are left in the typical section of Micrarionta; none of them is known anatomically, but I share the doubt expressed by Hanna as to the propriety of my former reference of these species to Sonorella. They do not have the special apical sculpture of the California-Arizona subgenus Eremarionta.

C. R. Orcutt has published his opinion that Margarita Island was the type locality of Helix pandorae, H. levis and H. areolata; also that these together with H. veatchii are varieties of a single species. Not having seen his material I should perhaps express no opinion on it, but some hundreds of shells from Margarita Island and its vicinity which I have examined lead me to deny the existence on that island of any snails properly referable to Micrarionta pandorae, levis or veatchii, whether these are considered distinct species or mere varieties. There are on Margarita Island several forms or varieties of M. areolata. Whether all of the Xerariontas of this coast are referable to one species or several is merely a matter of individual judgment in appraising their characters, and in the amplitude allowed to the species concept, admitted to be conventional.

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29 These forms were described and figured by Pilsbry in Proc. A. N. S. Phila. 1913, pp. 380-393, plates 15, 16, and Hanna, Proc. Calif. Acad. Sci. (4), XII, p. 505.

21 Described and partly figured under the generic name Sonorella, Nautilus XXIX, 1916, pp. 97-101, plate 2.


23 Nautilus XXXII, 1918, pp. 55-58.
15. **Micrarionta stearnsiana** (Gabb)

West shore of San Quintin Bay and on San Martin Island (G. D. Hanna).

"Three species of land shells were very common among brush thickets on the west side [of San Quintin Bay], the most noticeable being the large *M. stearnsiana*" (Hanna; 1925).

San Martin Island, lying a few miles northwest of San Quintin Bay, is wholly covered with lava.

16. **Micrarionta canescens** (Adams & Reeve)

Plate 11, figures 6-10

Proc. A. N. S. Phila. 1913, p. 386, fig. 1a-d (South Bay, Cedros I., H. N. Lowe); also pl. 15, fig. 12 (Natividad I.).


There appears to be no tangible difference between Cedros Island and Turtle Bay specimens. All of the lots are individually quite variable in size, degree of elevation, development of spiral sculpture and amount of banding. There is often the barely discernible trace of a columellar tooth, sometimes a distinct but very small one, and more often none whatever. In the lot from Natividad Island, none shows the columellar tooth. One from this place was figured as a form of *M. veatchii* in Proc. A. N. S. Phila. 1913, pl. 15, fig. 12.

Specimens from near Red Rocks (Pl. 11, figs. 7-10) and from the north side of Turtle Bay (Pl. 11, fig. 6) are figured.

17. **Micrarionta canescens veatchii** ('Newc.' Tryon)

Plate 11, figures 11-15

*Micrarionta veatchii* PILSBRY, Proc. A. N. S. Phila. 1913, p. 384, pl. 15, fig. 1-7, 10, 13-16.

Cedros Island: north end near the old mine; "Grand Canyon," near center of east side of island; Bernstein's Camp; South Bay (G. D. Hanna).
This well-known race differs from *M. canescens* by the generally more ample shell, typically with a higher spire and more expanded lip; it never has any trace of a columellar tooth. As it seems generally distinguishable from the more widely distributed *M. canescens* it may perhaps be allowed subspecific rank. It occurs only on Cedros Island.

Specimens from the old mine and the "Grand Canyon," and two labelled South Bay (Pl. 11, figs. 14, 15) are typical *watchii*. Those from Bernstein's Camp are nearly all more depressed, some typically colored, others with the coloration of the variety *leucanthea*; three are figured, Pl. 11, figs. 11-13.

18. **Micrarionta pandorae** (Forbes)

Plate 10, figures 1-16


East Benito Island; West Benito Island, living in abundance in the rock slides; on the north side, northeast point and south side (G. D. Hanna).

Large series were taken. While everywhere variable in color, there is less variation in form than in related species; and such local differentiation as exists is a matter of relative numbers of the various color-patterns in the several colonies. In the lot from East Benito (Pl. 10, figs. 1-9) bicolored and banded forms predominate, those of a nearly uniform shade being rare. A lot from the northeast corner of West Benito is similar. A small lot from the south side of West Benito (Pl. 10, figs. 10-12) contains 13 of vinaceous fawn color, nearly uniform or with an ill-defined band, or with strewn dusky spots, and four with lighter, banded base. A lot from the north side (Pl. 10, figs. 13-16) contains similar patterns, with also white, bicolored and nearly black specimens. A color plate would be needed for an adequate exposition of the color patterns of *M. pandorae*.

19. **Micrarionta levis** (Pfr.)


The specimens are similar to pl. 16, figs. 42, 43 of my paper of 1913. On Asuncion Island Dr. Hanna states that specimens were scarce and semifossilized; no live ones were found. Columnellar tooth is usually well developed but sometimes obsolete.

20. **Micrarionta levis crassula** (Dall)

Plate 10, figures 17-22

*Epiphragmophora crassula* DALL, Proc. A. N. S. Phila. 1900, p. 100, pl. 8, fig. 3.


Natividad Island; dead shells were everywhere in abundance, but not a live one could be found (G. D. Hanna).

All of the specimens yet found have the appearance of fossils, and have certainly been dead a long time. Most specimens are filled with sand, and have the appearance of being etched by blowing sand or worn by rolling. It appears to be extinct. The series of over 80 collected by the expedition of 1922 shows it to be rather variable as in Pl. 10, figs. 17-22, showing normal and extreme forms. There seem to be no constant characters to separate this Natividad Island form from mainland *M. levis*, and the subspecific rank gives too much importance to the Natividad form.

- Height 17.0, diam. 20.7 mm.; 5½ whorls.
- Height 18.0, diam. 18.8 mm.; 5½ whorls.
- Height 15.7, diam. 18.0 mm.; 5½ whorls.
- Height 12.0, diam. 15.5 mm.; 4½ whorls.
- Height 11.3, diam. 15 mm.; 5 whorls.

21. **Micrarionta areolata** (Pfeiffer)

Plate 6, figure 10; plate 11, figures 1-5; plate 9, figures 1, 1a, 1b


Magdalena Island near the village of Magdalena Bay; ocean beach, Magdalena Bay; Margarita Island, southern division; all collected by G. D. Hanna, July, 1922.
A series from the first locality mentioned consists of specimens having narrow, interrupted vandyke-brown bands, and agreeing exactly with Pfeiffer's figures.\(^{24}\) Probably this was the type locality. With them are others with the bands reduced, and also white, bandless shells (figs. 2-5).

The series from Margarita Island, south division (fig. 1), consists of 31 white shells, and 5 with small remnants of brown spot-bands, chiefly on the spire. Two measure:

- Height 22.0; diam. 26.5 mm.; 5½ whorls.
- Height 19.5; diam. 22.0 mm.; 5½ whorls.

A lot from the sand dunes on the ocean across from Magdalena Bay Village consists of thin, small shells, 19 to 21 mm. in diameter, white with very pale brown to ivory yellow spot-bands or tessellation, or uniform white. One of the lot measures 25 mm. in diameter.

One of the fine specimens of typical \textit{areolata} from near the village of Magdalena Bay was dissected and the genitalia figured, Pl. 9, figs. 1, 1a, 1b. The epiphallus (\textit{epi.}) is as large in diameter as the penis and much longer; it bears the penial retractor. The flagellum is coiled (fig. 1b, \textit{fl.}). The descending mucus gland (figs. 1, 1a, \textit{d.m.g.}) is spread out over the base of the dart sac (\textit{d.s.}) and vagina, the ascending one (fig. 1, \textit{a.m.g.}) spreads on the upper part of the dart sac. The diverticulum of the spermathecal duct (fig. 1, \textit{div.}) is very long and larger than the branch bearing the spermatheca. Length of penis 7 mm.; epiphallus 13 mm.; flagellum 40 mm. Length of spermatheca and duct 40 mm.; of diverticulum 28 mm.

The pallial organs are photographed in Pl. 6, fig. 10. The kidney is less than half as long as the lung, more than twice the length of the pericardium. The principal vein has numerous large branches anteriorly. Length of lung 33 mm.; of pericardium 5.5 mm.; of kidney 14 mm.

In 1898 I published\(^{25}\) figures of the genitalia of several Lower Californian \textit{Xerarionta}. The forms dissected from the San Benitos, Cedros and further south are much alike, dif-

\(^{24}\) Reproduced by me in Proc. A. N. S. Phila. 1913, p. 390, figs. 2a, b, c.

\(^{25}\) Proc. A. N. S. Phila., 1898, p. 68, pl. 1.
fering from *M. stearnsiana* of the San Diegan faunal area by having the descending mucus gland spread upon dart sac and vagina instead of on the penis. The flagellum and the diverticulum of the spermathecal duct are very long.

22. **Micrarionta evermanni** Pilsbry, new species

Plate 12, figures 4, 5, 6

Shell depressed, with low spire, rounded periphery and umbilicate base, the umbilicus contained nearly seven times in the diameter. Color unknown, as the specimens are bleached (fossil?), but a faintly sketched narrow dark band revolves above the periphery. The surface of the first whorl shows some weak irregular radial rugae; subsequent whorls are marked with light growth lines, otherwise smooth. The whorls increase rather slowly to the last, which expands to more than twice the width of the penult; it descends rather deeply to the aperture. The aperture is strongly oblique, very shortly oval, the outer margin rather conspicuously expanded, basal margin subreflected, columellar margin dilated and covering a small part of the umbilicus. Height 12.7 mm.; diam. 22.3 mm.; aperture 11.3x13.5 mm.; umbilicus 3½ mm.; 5 whorls; holotype, No. 2618. Height 11.7 mm.; diam. 19.7 mm.; 4½ whorls; paratype, No. 2619.

**Holotype**: No. 2618, **paratypes** Nos. 2619, 2620, Mus. Calif. Acad. Sci., from north side of **Turtle Bay, Lower California**, collected by G. D. Hanna and E. K. Jordan, June, 1925. Found among loose rocks in an outcrop of Pliocene gravelly strata about 1½ miles north of the bay shore and across the valley to the west of the white Miocene exposures.

This species is probably most nearly related to *M. merrilli* (Bartsch), described from below San Quintin, Lower California, but it differs by the larger aperture and the well expanded peristome, in these characters approaching *M. lohrii* (Gabb) somewhat.

The sculpture of the embryonic whorl is not well preserved, but such as there is resembles that of *M. lohrii*. These So-
norella-like Lower Californian species do not have the embryonic sculpture of the Californian desert Micrariontas of the subgenus Eremarionta, and they apparently belong to the typical section of Micrarionta, which is otherwise insular in distribution. To definitely fix their systematic position the dissection of some member of the group is desirable.

BULIMULIDÆ

23. *Bulimulus hannai* Pilsbry, new species

Plate 11, figures 16-20; plate 12, figure 3


The shell has a very ample umbilicus and ovate-conic shape; it is rather thin, light pinkish cinnamon with shreds of more yellowish, clay-colored periostracum. The conic spire is rather slender above. The initial whorls are strongly convex and delicately costulate as in related species; subsequent whorls are moderately convex, with very slight, retractive striation, and on the last one (to three) there are very delicate spiral threads which may be minutely beaded where well preserved (Pl. 12, fig. 3). The ovate, somewhat oblique aperture is carried well forward to the ventral convexity of the last whorl; it is colored inside like the exterior. The peristome is thin, moderately expanded, the margins connected by a short parietal callus. The columella is straightened but not plicate above, and very broad in an oblique view in the aperture. The internal axis (fig. 18) is large.

Length 38.5 mm.; diam. 22.7 mm.; length aperture 22.8 mm.; 6½ whorls.
Length 33.2 mm.; diam. 20.5 mm.; length aperture 20.5 mm.; 5½ whorls.
Length 31.0 mm.; diam. 20.0 mm.; length aperture 18.0 mm.; 5½ whorls (Type).

*Holotype:* No. 2621, *paratypes* Nos. 2622-2625, Mus. Calif. Acad. Sci., from Margarita Island in Magdalena Bay, Lower California; collected by G. D. Hanna under stones within one
mile, west and south, of the village near the center of the east side of the island.

*B. pallidior* (Sowb.) is more oblong, less acutely conic, the initial whorl larger and lower, the aperture is less oblique, with a more expanded lip, which is somewhat thickened within; the umbilicus is less ample within than in *B. hannai*, not penetrating as deep. In a specimen cut open from the back the axis is much smaller in *B. pallidior* than in *B. hannai*. All of the specimens of *B. pallidior* seen are white. In forms of *B. pallidior* which show granulation, it is of an entirely different character. In *B. hannai* the spiral threads are very narrow, widely spaced and usually in places show very beautiful minute beading, but more often they are almost or even completely effaced.

Two examples of *B. hannai* from Magdalena Island 4 miles south of the village of Magdalena Bay, collected by Hanna, have the spiral threads more strongly developed than in Margarita Island shells, though still very small.

*B. hannai* appears to be one of the most distinct species of its group, but since it has been confused with *B. pallidior striatulus*, some account of that race is required. This is the more essential because *striatulus* was only briefly defined, and the localities assigned seem to be incorrect or dubious.

24. *Bulimulus pallidior striatulus* Dall

Plate 12, figures 1, 7, 8


This variety was defined as follows:

"The spiral striation in many specimens [of *B. pallidior*] becomes pronounced, and in some reaches a point comparable to the surface of the *B. montezuma*. For this variety I have used the varietal name *striatulus*. It is particularly noticeable in collections from Carmen and Margarita islands and the Gulf coast of the peninsula."
I figured a specimen labelled "Lower California" as var. *striatulus* in Manual of Conchology XI, p. 143, pl. 19, figs. 50, 68, accepting J. G. Cooper’s identification of *striatulus* as identical with his race from the Sierra El Taste, called var. *vegexpiza* (so named because it “has characters like *B. vegetus*, *B. excelsus*, *B. spirifer* and *B. montezuma*!) This shell has sculpture substantially as in the type of *B. p. striatulus*.

Hanna mentioned *B. striatulus* as occurring on Margarita Island, having been misled by Dall's mention of that locality. The Margarita Island specimens never have sculpture “comparable to the surface of *B. montezuma*”—the only character mentioned by Dall. Also they differ decidedly in color (*striatulus* and “*vegexpiza*” being white), as well as in shape and peristome.

The type specimen of *B. p. striatulus* is No. 58652 U. S. N. M., from the R. E. C. Stearns collection, kindly lent me by Dr. Bartsch. It is said to be from Carmen Island, collector not known. Within the aperture “L. C.” is pencilled. It is represented in Pl. 12, fig. 8, the sculpture of the last whorl in figs. 1, 7; length 42 mm.; diam. 24 mm.; length aperture 24 mm.; 6⅞ whorls. The umbilicus is compressed and does not penetrate beyond the last whorl. There is a very dense, fine and low granulation, produced by the decussation of fine axial folds by many impressed spiral lines. At irregular intervals there are slightly emphasized spirals, as shown in fig. 1; but these are probably an individual rather than racial character. The greatest convexity of the last whorl is above the middle. The lip is white, well spread but not recurved at the margin, rather thick, and it is noticeably calloused at the inner edge. It is a fully adult or rather old individual. The margins of the peristome are somewhat chipped.

While not absolutely identical with "*vegexpiza*,” which differs by having a decidedly recurved lip, the resemblance is so

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28 Fig. 68 represents the granulation as decidedly too emphatic; it is actually very low. The lithograph printed darker than was intended.
29 Proc. Calif. Acad. Sci. (2), IV, p. 134, pl. 5, fig. 1; pl. 6, fig. 27.
great that I do not think two subspecies are likely to be maintained.

As to the assigned locality, Hanna doubts the occurrence of * striatulus * on Carmen Island, where the California Academy Expedition of 1921 worked well over the island and “collected almost 400 specimens of another species of Bulimus but not one of the montezuma group.” Stearns’ specimen probably was wrongly localized, and really came from the mainland mountains.

We conclude, therefore, that *B. pallidior striatulus* is a race of the southern peninsular sierras, and strongly distinct specifically from *B. hannah* of the Magdalena Bay region.

**Pupillidæ**

25. *Pupilla sterkiana* (Pilsbry)


San Martin Island (G. D. Hanna).

A few beautiful albino shells were taken among many of the normal brown color.

26. *Vertigo californica diegoensis* (Sterki)

San Quintin Bay, west shore; San Martin Island (G. D. Hanna).

Typical specimens; at the first locality only one old shell with *Sterkia hemphilli* (St.).

27. *Sterkia calamitosa martiniana* Pilsbry, new subspecies

Plate 12, figure 2

The shell is very similar to *S. calamitosa* but differs by the larger size and longer whorls, and the presence of a supra-palatal tubercle (rarely wanting).
Length 1.95 mm., diam. 0.9 mm.; fully 5 whorls. Holotype.
Length 1.75 mm., diam. 0.9 mm.; 5 whorls. Paratype.
Length 1.60 mm., diam. 0.9 mm.; smallest specimen.


There are a few beautiful albino examples in the lot. While very close to mainland calamitosa, the small differences seem to indicate a slightly differentiated insular race.

28. Sterkia hemphilli (Sterki)
San Quintin Bay, west shore (G. D. Hanna).

Truncatellidae

29. Truncatella stimpsoni Stearns
Plate 7, figures 10, 12-14

San Martin Island, Lower California, collected by Dr. Fred Baker, August, 1899.
One of this lot is illustrated, fig. 10. Other specimens from San Diego, the type locality, appear in figs. 12, 13 and 14, the last a very fine-ribbed form.

San Martin Island with the preceding (Dr. Fred Baker).
The specimens are almost smooth but show faint traces of ribs. While the two forms californica and stimpsoni are generally separable without difficulty, there appear to be a few intermediate specimens, such as the very finely ribbed shell from San Diego shown in Pl. 7, fig. 14, having about twice as many ribs as T. stimpsoni. The known range of T. californica
and *T. stimpsoni* is the same—San Diego, California, to San Martin Island, L. C.

These Truncatellæ were not taken by the expedition of 1922, but are included as giving a new southern limit for both.

**Amnicolidae**

31. *Paludestrina cedrosensis* Pilsbry, new species

Text figures 3a, b, c

The shell is openly perforate, conic with obtuse apex, thin, milky bluish and subtranslucent; smooth; composed of 3½ strongly convex whorls, the last becoming shortly free in front. The aperture is broadly ovate, the continuous peristome thin and slightly dilated outwardly, the columellar margin expanded; columella evenly concave, slightly thickened.

![Fig. 3. Paludestrina cedrosensis.](image)

Length 1.75 mm., diam. 1.35 mm., length of aperture 0.90 mm. Type, fig. 3c.
Length 1.75 mm., diam. 1.35 mm., length of aperture 0.95 mm. Fig. 3b.
Length 1.85 mm., diam. 1.30 mm., length of aperture 0.95 mm. Fig. 3a.

*Holotype:* No. 2628, *paratypes* Nos. 2629, 2630, from Bernstein's Spring, Cedros Island, Lower California; collected by G. D. Hanna, July, 1922.

The very thin yellowish operculum is retracted deep in the last whorl, out of sight in a front view in the aperture; nucleus
at the lower third of the length and the inner three-eighths of the width. Length, .8 mm.; width, .6 mm.

This little snail is more elongate than *Amnicola micrococcus* and shorter than *Paludestrina stearnsiana*; it appears to be related to the latter. It is the only fresh water mollusk known from Cedros Island. “Bernstein’s Spring is the water supply for an abalone packing plant located at the mouth of the southernmost large cañon on the east side of the island. The spring is located inland about three miles, on the north side of the cañon and at an elevation of about 2500 feet.” (G. D. H.).
Plate 6

All figures approximately X 3

Fig. 1. *Binneya notabilis* Cooper. No. 12204 (Acad. Nat. Sci. Philadelphia); Santa Barbara Island, Calif.; length, 13.3 mm.

Figs. 2, 4, 5. *Binneya guadalupensis* Pilsbry, n. sp. Nos. 2566-2570 (C.A.S.); Guadalupe Island, Lower California, three miles south of Northeast Anchorage; lengths, 11.2, 10.5 and 4.5 mm. Holotype, No. 2566.

Figs. 3, 6. *Binneya guadalupensis* Pilsbry, n. sp. Dormant specimens showing the white epiphragm which envelops non-retracted parts of the animal; Guadalupe Island, same location as above; lengths of shells, 8.7 and 6.3 mm.

Figs. 7, 8, 9. *Binneya guadalupensis* Pilsbry, n. sp. Alcoholic specimens, Nos. 2571-2573 (C.A.S.), with shells removed; fig. 9 is from a drowned individual; all from Pine Ridge, Guadalupe Island, Lower California; elevation 3000 feet.

Fig. 10. *Micrarioonta arcolata* (Pfeiffer). Pallial organs.
Plate 7

Fig. 1. *Pupilla guadalupensis* Pilsbry, n. sp. Holotype, No. 2575 (C.A.S.) from 1000 feet above Northeast Anchorage, Guadalupe Island, Lower California; length, 2.8 mm.

Fig. 2. *Pupilla guadalupensis* Pilsbry, n. sp. Paratype (toothless form), No. 2579 (C.A.S.) from two miles north of south end of Guadalupe Island, Lower California; length, 3.1 mm.

Fig. 3. *Pupilla goniodon* Pilsbry, n. sp. Holotype, No. 2574 (C.A.S.) from Northeast Anchorage, Guadalupe Island, Lower California; length, 4.0 mm.

Fig. 4. *Vertigo californica guadalupensis* Pilsbry, n. ssp. Holotype, No. 2582 (C.A.S.) from 1000 feet above Northeast Anchorage, Guadalupe Island, Lower California; length, 2.0 mm.

Fig. 5. *Vertigo californica catalinaria* Sterki. Plesiotype, No. 2581 (C.A.S.) from 1000 feet above Northeast Anchorage, Guadalupe Island, Lower California; length, 1.9 mm.

Fig. 6. *Vertigo degeneris* Pilsbry, n. sp. Holotype, No. 2583 (C.A.S.) from 1000 feet above Northeast Anchorage, Guadalupe Island, Lower California; length, 1.9 mm.

Figs. 7, 7a. *Haplotrema guadalupensis* Pilsbry, n. sp. Holotype, No. 2566 (C.A.S.) from Pine Ridge, Guadalupe Island, Lower California; elevation 3000 feet; diameter, 4.9 mm.

Fig. 8. *Helminthoglypta hannai* Pilsbry, n. sp. Paratype, No. 2561 (C.A.S.), small depressed form; from Pine Ridge, Guadalupe Island, Lower California; diameter, 17.0 mm.

Figs. 9, 9a, 9b. *Helminthoglypta hannai* Pilsbry, n. sp. Holotype, No. 2560 (C.A.S.) from Pine Ridge, Guadalupe Island, Lower California; diameter, 20.6 mm.

Fig. 10. *Truncatella stimpsoni* Stearns. No. 82436 (Acad. Nat. Sci. Philadelphia) from San Martin Island, Lower California.

Fig. 11. *Truncatella guadalupensis* Pilsbry. Figure on right is the type, No. 81973 (Acad. Nat. Sci. Phila.) from Guadalupe Island, Lower California.

Fig. 12-14. *Truncatella stimpsoni* Stearns. Nos. 10553 and 117903 (Acad. Nat. Sci., Phila.) from San Diego, California.
Plate 8

Fig. 1. *Micrariointa guadalupiana*; reproductive system of specimen from near Northeast Anchorage, Guadalupe Island, Lower California.

Fig. 1a. The same from below.

Fig. 2. *Micrariointa facta*; reproductive system; Santa Barbara Island, California.

Fig. 3. *Micrariointa guadalupiana*; reproductive system of paratype.

Fig. 3a. Section of the uterus of same at the point indicated by arrow.

Fig. 3b. Jaw of *Micrariointa guadalupiana*. Paratype.

*a.m.g.*, ascending mucus gland. *d.m.g.*, descending mucus gland. *d.s.*, dart sac. *fl.*, flagellum. *sp.*, spermatheca. *sp.d.*, duct of spermatheca.
Fig. 1. *Micraria arcolata*: reproductive system of specimen from near the village of Magdalena Bay.

Fig. 1a. Detail of dart sac and associated parts, from below.

Fig. 1b. Penis, with the flagellum partly uncoiled.

Fig. 2. *Bimucya guadalupensis*: lower part of the reproductive system.

Fig. 2a. Penis with the epiphallus partly pulled out.

Fig. 2b. Atrium and vagina spread open, showing the projecting lower part of the oviduct, and at 0 the opening of the spermathecal duct.

Figs. 2c, 2d. Sections of the oviduct cut at the points marked a-b and c-d respectively.

Fig. 3. Jaw of *B. guadalupensis*.


Fig. 1. *Micrarioita arocolata* (Pfeiffer). Plesiotype, No. 2631 (C.A.S.) from southern division of Margarita Island, Magdalena Bay, Lower California.

Fig. 2-5. *Micrarioita arocolata* (Pfeiffer). Plesiotypes, Nos. 2632-2635 (C.A.S.) from near village of Magdalena Bay, Lower California; probably topotypes.

Fig. 6. *Micrarioita canescens* (Adams & Reeve). Plesiotype, No. 2590 (C.A.S.) from Turtle Bay, Lower California.


Figs. 16-20. *Bulinulus hannai* Pilsbry, n. sp. Holotype (fig. 19), No. 2621, and paratypes, Nos. 2622-2625 (C.A.S.) from Margarita Island in Magdalena Bay, Lower California; from about one mile southwest of settlement on east side of island, near center.
Fig. 1. *Bulimulus pallidior striatulus* Dall. Showing sculpture of last whorl of holotype, No. 58052 (U. S. Nat. Mus.) from mountain district of Lower California, probably.

Fig. 2. *Sterkia calamitosa martiniiana* Pilsbry, n. ssp. Holotype, No. 2626 (C.A.S.) from San Martin Island, Lower California.

Fig. 3. *Bulimulus hannai* Pilsbry, n. sp. Sculpture (x10) of portion of base of holotype, No. 2621 (C.A.S.) from Magdalena Bay, Lower California.

Figs. 4-6. *Micrarionta evermanni* Pilsbry, n. sp. Holotype, (figs. 4, 5). No. 2618, and paratype, No. 2619 (C.A.S.) from north side of Turtle Bay, Lower California.

Fig. 7. *Bulimulus pallidior striatulus* Dall. Sculpture of left side of last whorl of holotype (x6, approximately) No. 58052 (U. S. Nat. Mus.).

Fig. 8. *Bulimulus pallidior striatulus* Dall. Holotype, No. 58052 (U. S. Nat. Mus.) probably from mountain district of Lower California.
It has been known for many years that some of the Eocene rocks on the west side of the San Joaquin Valley near Coalinga, California, contain large numbers of Foraminifera. F. M. Anderson was apparently the first to publish a note on the occurrence. In 1905\(^1\) he listed seven genera, *Nodosaria, Lagena(?), Sagrina, Vaginulina, Cyclammina, Pulvulina* [Pulvinilina], and *Polymorphina(?)*, most of these having come from one block of rock in Sec. 9, T. 19 S., R. 15 E., nine miles north of Coalinga. This block passed through the San Francisco fire of 1906, is still in a well preserved condition and registered as No. 607 of the Academy’s series of types. The material considered in the present paper came from about two miles south of Anderson’s locality and is unquestionably from the same formation.

He called this formation “Kreyenhagen,” correlation having been made with the type locality of that formation on Canoas Creek several miles to the southward. This apparently stood uncontested until 1915 when Robert Anderson and R. W.

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Pack referred certain overlying, diatomaceous shales, probably Miocene in age, to the Kreyenhagen and called it doubtfully "Oligocene". The true Eocene shales here being considered were referred to the Tejon formation, upper Eocene. The present junior author endeavored to clear up the confusion surrounding the name "Kreyenhagen" in 1925 when an attempt was made to show that the formation at the type locality was Eocene, not Oligocene, and that its equivalent north of Coalinga was the Eocene formation from which F. M. Anderson took his Foraminifera. Studies since that date have tended to strengthen that contention.

Therefore, the Kreyenhagen Shale, as now understood, is an important lithologic unit, widely distributed on the west side of the San Joaquin Valley and often about 1000 feet thick. In most cases it consists of a fairly uniform, soft, muddy shale. Localized lenses or thin strata are highly fossiliferous and a considerable molluscan fauna has been described from them or from immediately adjacent sandstones. Regarding the Eocene age of the formation there can be no question but there has been some difference of opinion as to the stratigraphic position in the column. It is of course the uppermost definitely recognized Eocene exposed in the region and is obviously not to be compared to the Martinez, lower Eocene. The Mollusca are similar in many ways to the Tejon which has been considered by all recent geologists to be very near the top, if not actually the top, of the Eocene. Yet there are some notable differences in the faunas and these are so pronounced that some have considered the Fresno County deposits about middle Eocene. Here we encounter a maze of formation-names in the literature, with many differences of opinion; in fact a complicated problem is presented.

Professor Clark’s latest contribution to the subject shows that he considers the mass of muddy shales to be of “Meganos,” middle Eocene age. These lie mostly below the Eocene sandstone reef, used as a guide in this section, and it is from them that many of our species of Foraminifera have come. Evidently “Meganos” used in this connection is exactly synonymous with the earlier name “Kreyenhagen.” Sands overlying these shales have been named “Domijean” by F. M. Anderson,6 the name being modified to “Domijean” by some later writers. Clark recognized the distinctness of this formation and likewise classified it as middle Eocene. Former writers have considered it to be upper Eocene, the equivalent of the typical Tejon. He considered the Tejon to be missing in that section.

Unfortunately, Foraminifera have not been found at the type locality of the Tejon. The present collection, however, includes samples from a few feet above the sandy reef to several hundred feet below and into the muddy shales and the organisms in them are so distributed that it appears we are dealing with one formational unit. This fauna is very closely related to that of the upper Eocene of the Gulf Coastal Plain region of the United States and Mexico. The relationship with the Mexican region is perhaps a little closer than with that of the Coastal Plain of the United States. This relationship amounts to identity of species in some cases. There are several species, however, which have apparently not been found heretofore and are described herein as new.

On account of this study having been based on a single section it is hardly safe to form positive conclusions therefrom; nevertheless, the evidence we have indicates that the exposure at this locality is well up in the Eocene and probably the equivalent of at least a part of the Tejon. The earliest name applied to the lower, muddy-shale phase is “Kreyenhagen”; and the earliest name applied to the upper, sandy phase is “Domijean.”

One species of Foraminifera, Orthophragmina clarki Cushman7 has been described from what appears to be an extension northward of the shales from which the present collection was

derived. It came from the "northeast side of Domengine Creek near the corner of the SW¼ Sec. 29, T. 18 S., R. 15 E., M. D. M." from strata classified as "Meganos", (middle Eocene) by Dr. Clark. What is probably the same species was figured by Arnold & Anderson,8 as "Orbitolites sp. a" from the southwest flank of Reef Ridge, north of McLure Valley, Sec. 27, T. 23 S., R. 17 E. This locality can hardly be other than an extension of the exposure southward from the type locality of the Kreyenhagen Shale. The species occurs sparingly throughout the 1000 feet of muddy shales at the locality here being considered, (873 C.A.S.).

The present collection came from a section across the Eocene exposure southeast of the old camp of "Oil City" which was run in 1924 by J. A. Taff, E. G. Gaylord, and G. D. Hanna. It is in the NW¼ Sec. 20, T. 19 S., R. 15 E. A conspicuous feature of the landscape there is a high sandstone reef or ridge, as seen from Oil City, looking southeast. This Eocene reef contains many molluscan fossils and was used as a base for measurement. The collections came from 10 feet above the reef, 100, 200 and 1000 feet below the reef on the exposure facing northwest. The latter depth is near the shale contact between the Eocene "Kreyenhagen" and the Cretaceous "Moreno" below. This contact is very difficult to follow satisfactorily at that point except by means of the Foraminifera; faunal differences are very pronounced.

Above the Eocene reef at the point indicated, the muddy shales gradually become more and more siliceous. No evident unconformity was seen at that point and there appeared to be continuous sedimentation. These siliceous shales become highly organic and are the source-rock of most of the petroleum of the Coalinga district. They contain what has been called "Pecten peckhani Gabb" and in the upper part a very considerable number of micro-organisms which have been reported from deposits definitely known to be of Miocene age. They lie below a sandstone reef which is often called "Vaqueiros" but may not be extreme basal Miocene. Only four species of Mollusca have been reported from this huge body of shale, throughout its extent and these are hardly suf-

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8 U. S. Geol. Surv. Bull. 396, 1909, p. 13, pl. 3, fig. 6; Bull. 398, p. 70, pl. 25, fig. 6.
sufficient to identify the formation as either Miocene, Oligocene or Eocene; in all of these it has been variously placed in the past. It overlies Eocene without unconformity and upper Eocene is reported missing in the region. Therefore, it might be contended that these shales are Tejon. Being between known Miocene and known Eocene, they can also be called Oligocene. And being, in large part, highly siliceous like some basal Miocene elsewhere, they can be called Miocene. Since they contain a large fauna of Foraminifera in some parts and Radiolaria, Silicoflagellata and Diatomaceae in many places and through a considerable vertical range, the safest procedure seems to be to consider the age in doubt until some of these groups of organisms are critically studied. Stratigraphy seems to be incapable of furnishing a means of age determination in this case and molluscan paleontology is equally deficient. It is possible, even probable, that the point of separation between Eocene and higher strata is a shale contact and will have to be based on the micro-organisms as does the Eocene-Cretaceous contact below.

1. **Rhabdammina eocenica** Cushman & Hanna, new species

Plate 13, figure 1

Test cylindrical, slightly irregular, open at both ends; wall arenaceous with some sand grains but a large percentage of fine amorphous material, the whole firmly cemented; apertures at the ends of the chambers which are somewhat constricted. Length 3 mm., breadth 0.5 mm.


The specimens vary somewhat in diameter but the ratio of diameter to length is rather constant indicating that the specimens may perhaps be considered reasonably complete. They are usually slightly compressed, probably due to fossilization and later stresses. The amount of fine material is relatively larger than in most recent species.

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2. Bathysiphon eocenica Cushman & Hanna, new species

Plate 13, figures 2, 3

Test elongate, compressed cylindrical; wall made of fine white amorphous material and rather soft; wall thick but the tubular chamber several times as broad as the thickness of the wall; outer surface with traces of a reddish coating. Length of short pieces 1 mm., breadth 0.5 mm.

*Holotype:* No. 2524, *paratypes* Nos. 2525, 2526, Mus. Calif. Acad. Sci., from *seven miles north of Coalinga, California*; specimens from 10 feet above the Eocene sandstone reef; also from 100 feet below.

In some respects this species resembles *Bathysiphon taurinensis* Sacco, especially as figured by Schubert from the lower Oligocene of Austria. Both species are apparently constricted at intervals and a line of weakness develops there causing the specimens in the samples when washed to be broken up into relatively short pieces. It is apparently a larger and thicker walled species than *B. taurinensis*.

3. Haplophragmoides coalingensis Cushman & Hanna, n. sp.

Plate 13, figure 4

Test comparatively large, coarsely arenaceous but the surface smoothly finished due to the considerable amount of whitish cement, close coiled, planospiral, involute, very slightly umbilicate, last-formed coil composed of ten to twelve chambers; sutures very indistinct but slightly depressed in the later portion; aperture narrow, curved, at the base of the last-formed chamber. Length 1 mm., breadth 0.8 mm., thickness 0.45 mm.

*Holotype:* No. 2527, Mus. Calif. Acad. Sci., from *seven miles north of Coalinga, California*; fairly common 10 feet above the Eocene sandstone reef; also 100 feet and 200 feet below it.

The relatively large size, very smooth surface due to the
abundance of cement into which the relatively large sand grains are stuck, together with the large number of chambers in the involute test should make this species easily recognized.

4. **Textularia mississippiensis** Cushman

Plate 13, figure 5


Test elongate, compressed, broad, thickest in the median line, thence thinning toward the periphery, in end view biconvex, central portion curved, lens shaped; chambers low and broad, especially in the early stages, somewhat higher in the adult; sutural region covered by a coarsely arenaceous layer, meeting along the central portion and periphery, leaving the central portion of each chamber uncovered; periphery thin and irregular not definitely or regularly spinose, chamber-walls finely arenaceous, smoothly finished except as noted.

*Plesiotype:* No. 2528, Mus. Calif. Acad. Sci., from seven miles north of Coalinga, California; rare, 10 feet above the Eocene sandstone reef.

This species is characteristic of the upper Eocene and lower Oligocene of the United States and Mexico.

5. **Textularia** cf. *distortio* Cushman & Applin

Plate 13, figure 6

There is a single incomplete specimen which strongly resembles this species described from the upper Eocene of Texas. It may be simply an eroded specimen of *T. mississippiensis* but seems worthy of note for the information of future workers.

*Plesiotype:* No. 2529, Mus. Calif. Acad. Sci., from seven miles north of Coalinga, California; rare, 100 feet below the Eocene sandstone reef.
6. **Gaudryina jacksonensis coalingensis**  
Cushman & Hanna, new subspecies  
Plate 13, figure 7

Test slightly curved, triangular in section, early portion triserial, later adult portion biserial, chambers and sutures rather indistinct in most specimens due to the unusually rough texture of the exterior. Length 1.25 mm., breadth 0.80 mm.

*Holotype:* No. 2530, *paratype* No. 2531, Mus. Calif. Acad. Sci., from seven miles north of Coalinga, California; common in the material collected 10 feet above the Eocene sandstone reef, but not found in the lower samples.

This variety differs from typical *Gaudryina jacksonensis* Cushman in the somewhat shorter form and the very rough exterior. *G. jacksonensis* is found in the upper Eocene of the United States and Mexico.

7. **Bulimina** sp.?  
*Bulimina* sp.?, Cushman, Bull. Amer. Assoc. Petr. Geol., Vol. 9, No. 2, 1925, p. 301, pl. 7, fig. 9.

In the collection are a very few small smooth Buliminas which are apparently identical with the specimen figured as cited above. It was from upper Eocene material collected on the Moctezuma River in the State of Vera Cruz, Mexico. Other species of this Mexican locality occur in the California samples and when sufficient material is available it may be found that this is a definite upper Eocene species.

Specimens were found 100 feet and 200 feet below the Eocene Reef.

8. **Nodosaria latejugata** Gümbel  
Plate 13, figures 15-17


*Nodosaria budensis* Hantken, A. magy. Kir. földt. int. Evkön., Vol. 4, 1875 (1876), p. 23, pl. 2, fig. 10; pl. 16, fig. 4.
Test elongate, subcylindrical, initial end with a single spine; chambers distinct, slightly inflated; sutures distinct, of clear shell material, slightly depressed; surface ornamented with a few very prominent longitudinal costæ, continuous from initial to apertural ends, except occasionally the final chamber smooth; apertural end slightly prolonged; aperture radiate. Length up to 2 mm.; breadth up to 0.60 mm.

*Plesiotypes:* Nos. 2532-2534, Mus. Calif. Acad. Sci., from *seven miles north of Coalinga, California*; there are numerous specimens from 10 feet above and 100 feet below the Eocene sandstone reef.

This species was originally described by Gümbel from the upper Eocene of Bavaria. Hantken figures it from the upper Eocene of Hungary. It is common in the American upper Eocene of the Gulf Coastal Plain region of the United States and Mexico in both microspheric and magalospheric forms. This is one of the species belonging to the general *Nodosaria raphanus* group, various species of which are known from the Cretaceous to the Recent ocean.

9. *Nodosaria aculeata* d’Orbigny (?)


There is a single broken fragment consisting of two globular chambers from the middle portion of a test with prominent radiating spines that may be placed under this species. It came from 10 feet above the Eocene Reef.

10. *Nodosaria* (Dentalina) *adolphina* d’Orbigny

Plate 13, figures 8, 9


*Nodosaria adolphina* Schwager, Novara-Exped., Geol. Theil., 1866, p. 235, pl. 6, figures 72, 73.

Test elongate, slightly curved, the chambers rounded, increasing gradually in size as added, each connected by short
slender necks with the adjacent ones; wall smooth except near the base where there is a ring of sharp, backwardly pointing spines.

*Plesiotypes:* Nos. 2535, 2536, Mus. Calif. Acad. Sci., from *seven miles north of Coalinga, California*; specimens occur at 10 feet above and 200 feet below the Eocene sandstone reef.

Originally described by d’Orbigny from the Miocene of the Vienna Basin this species has been widely recorded. It occurs in the upper Eocene of Mexico.

11. *Nodosaria (Dentalina) consobrina* d’Orbigny

*Plate 13, figures 12, 13*


Test elongate, slightly curved, the chambers elliptical, somewhat constricted at the sutures, increasing in size and length as added, initial end usually with a spine, wall smooth, matte.

*Plesiotypes:* Nos. 2537, 2538, Mus. Calif. Acad. Sci., from *seven miles north of Coalinga, California*; numerous fragments occur in the collection from 10 feet above the Eocene sandstone reef.

This species originally described by d’Orbigny from the Miocene of the Vienna Basin occurs in the Eocene of Mexico. It is a delicate species; on account of the weakness developed at the constricted sutures fossil specimens are usually broken.

12. *Nodosaria (Dentalina) communis* (d’Orbigny)

*Plate 13, figure 10*


*Nodosaria communis* REUSS, Verstein Böhm. Kreide, 1845, 6, p. 28, pl. 12, fig. 21.

Test stout, tapering, slightly curved, initial end pointed, sometimes ending in a short spinose projection, chambers numerous, very slightly depressed at the sutures, increasing
gradually in height as added; wall smooth, aperture radiate, eccentric. Length 1.10 mm., breadth 0.20 mm.

*Plesiotype:* No. 2539, Mus. Calif. Acad. Sci., from **seven miles north of Coalinga, California**; specimens occur in the collection from 10 feet above the Eocene sandstone reef.

13. **Nodosaria arundinea** Schwager

Plate 13, figure 14


Test very long and slender, chambers long cylindrical, many times as long as wide; sutures very slightly depressed; wall thin, smooth.

*Plesiotype:* No. 2540, Mus. Calif. Acad. Sci., from **seven miles north of Coalinga, California**; rare at 10 feet above the Eocene sandstone reef.

The species is recorded from the Eocene of Europe and occurs in considerable numbers in the upper Eocene of Mexico. Schwager’s types were from the Pliocene of Kar Nicobar.

14. **Nodosaria (Glandulina) laevigata ovata**

Cushman & Applin

Plate 14, figure 1


Test ovate, longer than broad, circular in transverse section, widest toward the apertural end, initial end subacute, chambers overlapping, few, indistinct; sutures indistinct; aperture radiate, slightly projecting; wall smooth, matte. Length 0.75 mm., breadth 0.40 mm.

*Plesiotype:* No. 2541, Mus. Calif. Acad. Sci., from **seven miles north of Coalinga, California**; a single specimen from 10 feet above the Eocene sandstone reef.

April 22, 1927
This variety, described from the upper Eocene of Texas, is widely distributed in the deposits of the same age of the Gulf Coastal Plain of the United States and Mexico.

15. **Marginulina subbullata** Hantken

   Plate 13, figure 11


Test subcylindrical, initial end broadly rounded, the first three chambers arranged in a loose coil, the last two or three chambers uniserial in a straight line; chambers few, inflated; sutures distinct, slightly depressed; wall smooth and polished; apertural end produced with a small tapering neck and radiate aperture. Length of immature specimen 0.50 mm., breadth 0.25 mm.

*Plesiotype:* No. 2542, Mus. Calif. Acad. Sci., from seven miles north of Coalinga, California; a single specimen, 200 feet below the Eocene sandstone reef.

Hantken described this species from the upper Eocene of Central Europe. It also occurs in the upper Eocene of Mexico.

16. **Cristellaria mexicana nudicostata**

   Cushman & Hanna, new subspecies

   Plate 14, figure 2

Test differing from the typical in having the raised limbate sutures smooth instead of beaded, the portion toward the inner margin from the middle slightly more swollen; aperture radiate with a supplementary robuline aperture below on the apertural face.

*Holotype:* No. 2543, *paratype* No. 2544, Mus. Calif. Acad. Sci., from seven miles north of Coalinga, California; several
specimens at 10 feet above and 100 feet below the Eocene sandstone reef.

This same form occurs in the Tantoyuca formation of Mexico.

17. **Cristellaria truncana** Gümbel

Plate 14, figure 6


Test much compressed, slightly uncoiled, two or three times as long as broad, sides nearly parallel, periphery truncate; chambers very distinct; sutures distinct, transparent, limbate, curved especially toward the periphery; wall smooth, polished; aperture radiate with a small rounded supplementary robuline aperture just below on the apertural face. Length 0.85 mm., breadth 0.40 mm.

*Plesiotype:* No. 2545, Mus. Calif. Acad. Sci., from seven miles north of Coalinga, California; rare in collection 100 feet below Eocene sandstone reef.

This is apparently identical with Gümbel's species described from the upper Eocene of Bavaria.

18. **Cristellaria inornata** (d'Orbigny)

Plate 14, figure 5


Test closely coiled, thick, periphery acute, six or seven chambers in the last formed coil, chambers distinct but not inflated: sutures distinct, slightly limbate, strongly curved, flush with the surface; wall smooth, matte; aperture radiate with an elongate supplementary robuline chamber just below on the triangular apertural face. Length 0.95 mm., breadth 0.80 mm.
Plesiotype: No. 2546, Mus. Calif. Acad. Sci., from seven miles north of Coalinga, California; a number of specimens occur in the collection made 100 feet below the Eocene sandstone reef.

D'Orbigny described this species from the Miocene of the Vienna Basin and Sherborn & Chapman record it from the Eocene of England. There are a number of specimens from the same material near Coalinga that may be variants of this species.

19. **Cristellaria convergens** Bornemann

Plate 14, figure 3


Test oval, biconvex, close coiled; chambers triangular, the last-formed one drawn out to a point at the apertural end; sutures hardly visible, the chambers embracing to the umbo; wall smooth and thick, aperture radiate. Length 0.65 mm.; breadth 0.55 mm.

Plesiotype: No. 2547, Mus. Calif. Acad. Sci., from seven miles north of Coalinga, California; specimens occur in the collection made 100 feet below the Eocene sandstone reef.

Bornemann's type was from the Oligocene of Germany. Specimens from Jurassic to Recent have been referred to this species but a comparison of the published figures shows a considerable difference in the forms.

20. **Cristellaria subaculeata** Cushman


Test somewhat longer than broad, somewhat compressed, periphery with a narrow, thin keel, test becoming slightly uncoiled in the later portion; chambers comparatively few, about
8 in the last-formed coil, distinct but not inflated; sutures limbate, raised, with bead-like prominences, wall between the sutures also spinose or beaded, apertural face triangular, truncate, the sides with a raised keel; aperture projecting, radiate, with a supplementary robuline opening below on the apertural face. Length 0.85 mm., breadth 0.60 mm.

Specimens occur in the collection from 200 feet below the Eocene sandstone reef, seven miles north of Coalinga, California. The specimens are very close indeed to the species now living in the western Atlantic.

21. Cristellaria subaculeata glabrata Cushman

Variety differing from the typical in the larger proportion of the uncoiled part, the greater development of spines on the periphery and the lack of ornamentation of the wall between the sutures.

This variety occurs with the typical form in the material collected 200 feet below the Eocene sandstone reef, seven miles north of Coalinga, California.

22. Globigerina bulloides d'Orbigny


A few specimens came from 200 feet below the Eocene sandstone reef, seven miles north of Coalinga, California.

23. Globigerina coalingensis Cushman & Hanna, new species

Plate 14, figures 4a, b

Test subglobular, the last three chambers making up nearly the whole periphery of the test, early chambers largely concealed by the ornamentation which is greatest over the early chambers; consisting of large projecting bosses with a spinose surface, the succeeding chambers covered with a progressively
decreasing ornamentation, the last-formed chamber with only a few short slender spines; aperture small, in the slightly open umbilicus of the ventral side. Diameter 0.60 mm.

_Holotype:_ No. 2548, Mus. Calif. Acad Sci., from seven miles north of Coalinga, California; rare at 200 feet below the Eocene sandstone reef.

This species is peculiar in its ornamentation but in this respect strongly resembles _Globigerina topilensis_ Cushman described from the upper Eocene of Mexico. The California species has rounded instead of angled, truncated chambers and the ornamentation decreases much more rapidly.

**24. Truncatulina pseudoungeriana** Cushman


Test almost equally biconvex, periphery subacute; chambers nine to eleven in the last-formed whorl, those of the earlier whorls not showing on either the ventral or the dorsal side, being hidden on the dorsal side by the roughness of the surface and on the ventral side by the involute character; periphery lobulate; sutures distinct above the last whorl and very distinct below, as they are somewhat tumid on the ventral side; umbilical region filled nearly flush with the chambers by clear shell material, last few chambers on the dorsal side slightly above the surface on the inner margin; surface dorsally with coarse punctae, below smooth and more finely puncate; aperture at the periphery. Diameter 1 mm. or less.

Specimens, evidently this species, occurred at 10 feet above and 200 feet below the Eocene sandstone reef.

This species is common in the Oligocene and upper Eocene of the Gulf Coastal Plain of the United States and Mexico.
25. **Truncatulina coalingensis** Cushman & Hanna, new species

Plate 14, figures 7-9

Test comparatively large, dome shaped, ventral side slightly concave, dorsal-side strongly convex, the central portion umbo-nate, periphery with a strong blunt keel; chambers about eight in the last-formed coil, somewhat indistinct on the dorsal side but much more distinct on the ventral side; sutures on the ventral side rather indistinct, very slightly curved; on the ventral side distinct, only slightly curved, limbate; wall thick, dorsal side irregularly pitted, except on the peripheral keel which is nearly smooth; ventral side finely but very distinctly perforate, toward the umbilical area with several large confluent boss-like, smooth projections; aperture narrow, on the ventral side of the last-formed chamber. Diameter 1.15 mm.

*Holotype:* No. 2549, *paratype* No. 2550, Mus. Calif. Acad. Sci., from *seven miles north of Coalinga, California*; common in the collection made 10 feet above the Eocene sandstone reef.

This is a peculiar species in its shape and especially in the character of the ornamentation.

26. **Anomalina coalingensis** Cushman & Hanna, new species

Plate 14, figures 10-12

Test plano-convex, ventral side convex, dorsal side nearly flat, periphery bluntly keeled; chambers very distinct, eleven to thirteen in the last-formed coil, on the dorsal side with the border of each chamber with a distinct thickened border, the inner end roundly pointed and distinctly free from the preceding coil; the earlier coils forming a flat coarsely pitted disc, ventral side involute with the chambers ending in a central raised boss, the sutures slightly curved, wall coarsely perfor-
ate; aperture short, at the periphery and extending slightly over onto the ventral side. Diameter 0.60 mm.

Holotype: No. 2551, paratypes Nos. 2552, 2553, Mus. Calif. Acad. Sci., from seven miles north of Coalinga, California; fairly common at 10 feet above and 200 feet below the Eocene sandstone reef.

The ventral side is distinctly raised in the middle, the figure showing about the maximum; other specimens are more compressed. This is related to Anomalina umbonata Cushman described from the Eocene of Mexico.

27. Pulvinulina mexicana Cushman

Plate 14, figures 13-15

Pulvinulina mexicana Cushman, Bull. Amer. Assoc. Petr. Geol., Vol. 9, 1925, p. 300, pl. 7, figs. 7, 8.

Test unequally biconvex, dorsal side forming a low cone, ventral side only slightly biconvex, periphery subacute, subcarinate, last-formed coil with eight to ten chambers, only those of the last-formed coil visible from the ventral side, which is umbonate; sutures distinct, very slightly limbate on the dorsal side, ventrally very slightly depressed near the periphery, becoming limbate near the umbilicus, and often fusing on the inner margin and forming a ring; wall distinctly but rather finely perforate; aperture elongate on the middle part of the inner margin of the ventral side of the last-formed chamber. Diameter, 0.60 mm.

Plesiotype: No. 2554, Mus. Calif. Acad. Sci., from seven miles north of Coalinga, California; specimens were common at 100 feet below the Eocene sandstone reef.

This species was originally described from the Eocene of Mexico.
28. *Pulvinulina crassata* Cushman

*Pulvinulina crassata* Cushman, Bull. Amer. Assoc. Petr. Geol., Vol. 9, 1925, p. 300, pl. 7, fig. 4.

Test small, plano-convex, the dorsal side nearly flat, ventral side strongly convex, last-formed coil with five or six chambers; periphery subacute; chambers inflated, especially on the ventral side; sutures distinct, slightly depressed on the dorsal side, strongly so on the ventral side; periphery and surface closely set with short spinose processes; aperture elongate, on the inner edge of the ventral face of the last-formed chamber. Diameter, 0.45-0.55 mm. Rare at 200 feet below the Eocene sandstone reef.

This species occurs with the above in the Eocene of Mexico.

29. *Gyroidina soldanii* d’Orbigny, *octocamerata*  
Cushman & Hanna, new subspecies  
Plate 14, figures 16-18

Test small, dorsal side flattened, ventral side very convex, composed of about three coils, the last formed one consisting of eight chambers, periphery broadly rounded, ventral side with the umbilical region strongly depressed; chambers distinct, sutures distinct, slightly depressed, on the dorsal side somewhat oblique, on the ventral side radial; wall finely perforate, smooth and polished; aperture elongate, arched, from the periphery at least half way to the umbilicus along the ventral border of the last formed chamber, with a very slightly developed lip. Length 0.50 mm., breadth 0.45 mm., thickness 0.35 mm.

*Holotype:* No. 2555, Mus. Calif. Acad. Sci., from seven miles north of Coalinga, California; rare at 10 feet above the Eocene sandstone reef.

This variety occurs frequently in the upper Eocene of the Gulf Coastal Plain of the United States and Mexico.
30. Discocyclina clarki (Cushman)


This species is abundant in parts of the muddy shale for several hundred feet below the sandstone reef. Except where there has been local consolidation, the preservation is not good.

31. Nonionina cf. umbilicatula (Montagu)

There are a very few specimens from 100 feet below the Eocene reef near Coalinga, which may be referred to this species, at least temporarily. Such specimens are widely distributed and need special study to determine the extent of range in the various species. They are very common in the Eocene of the Gulf Coastal Plain of the United States and Mexico.

32. Nonionina cf. scapha (Fichtel and Moll)

Plate 14, figures 19, 20

A very few specimens in the collection may be doubtfully referred to this species.

Plesiotype: No. 2556, Mus. Calif. Acad. Sci., from 100 and 1000 feet below the Eocene reef, seven miles north of Coalinga, California.

33. Massilina decorata Cushman

Massilina decorata Cushman, U. S. Geol. Survey Prof. Paper 129, 1922, p. 143, pl. 34, fig. 7; Prof. Paper 133, 1923, p. 55.

Test much flattened, elliptical or oval, slightly longer than broad, basal and apertural ends projecting, the apertural end narrowing to a small cylindrical neck, nearly in the longitudi-
nal axis of the test; sutures rather indistinct; surface dull white; periphery rounded, the wall ornamented by very fine pits, giving a finely granular, matte appearance to the test. Maximum length 1 mm.

A single specimen came from 200 feet below the Eocene sandstone reef, seven miles north of Coalinga, California.

This species is widely distributed in the lower Oligocene and upper Eocene of the Gulf Coastal Plain of the United States and Mexico.
PLATE 13

Fig. 1. *Rhabdamminia eocenica* Cushman & Hanna, n. sp. Holotype, No. 2522, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 209.

Figs. 2, 3. *Bathyntoph eocenica* Cushman & Hanna, n. sp. Fig. 2, paratype, No. 2525; fig. 3, holotype, No. 2524, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 210.

Fig. 4. *Haplophragmoides coalingensis* Cushman & Hanna, n. sp. Holotype, No. 2527, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 210.

Fig. 5. *Textularia mississippiensis* Cushman. Plesiotype, No. 2528, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 211.

Fig. 6. *Textularia cf. distortio* Cushman & Applin. Plesiotype, No. 2529, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 100 feet below sandstone reef; p. 211.

Fig. 7. *Gaudryina jacksonensis coalingensis* Cushman & Hanna, n.s. sp. Holotype, No. 2530, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 212.

Figs. 8, 9. *Nodosaria (Dentalina) adolphina* d’Orbigny. Plesiotypes, Nos. 2535, 2536, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 213.

Fig. 10. *Nodosaria (Dentalina) communis* d’Orbigny. Plesiotype, No. 2539, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 214.

Fig. 11. *Marginulina subbullata* Hantken. Plesiotype, No. 2542, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 200 feet below sandstone reef; p. 216.

Figs. 12, 13. *Nodosaria (Dentalina) consobrina* d’Orbigny. Plesiotypes, Nos. 2537, 2538, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 214.

Fig. 14. *Nodosaria arundinea* Schwager. Plesiotype, No. 2540, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 215.

Fig. 15. *Nodosaria latejungata* Gümbl, microspheric form. Plesiotype, No. 2534, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 212.

Figs. 16, 17. *Nodosaria latejungata* Gümbl, megalospheric forms. Plesiotypes, Nos. 2532, 2533, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 212.

All figures on this plate are enlarged approximately 50 diameters; see foregoing text for accurate measurements of the specimens. The carinate appearance of some of the figures is due to the method of engraving the plate.
Fig. 1. *Nodosaria (Glandulina) laxigata ovata* Cushman & Applin. Plesiotype, No. 2541, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 215.

Fig. 2. *Cristellaria mexicana nudicostata* Cushman & Hanna, n. s. sp. Holotype, No. 2543, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 216.

Fig. 3. *Cristellaria convergens* Bornemann. Plesiotype, No. 2547, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 218.

Fig. 4a, 4b. *Globigerina coalingensis* Cushman & Hanna, n. sp.; a, side view; b, dorsal view. Holotype, No. 2548, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 200 feet below sandstone reef; p. 219.

Fig. 5. *Cristellaria inornata* d'Orbigny. Plesiotype, No. 2546, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 217.

Fig. 6. *Cristellaria truncata* Gümbel. Plesiotype, No. 2545, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 100 feet below sandstone reef; p. 217.

Figs. 7, 8, 9. *Truncatulina coalingensis* Cushman & Hanna, n. sp. Holotype, (fig. 7) No. 2549; paratype, (figs. 8, 9) No. 2550, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 221.

Figs. 10, 11, 12. *Anomalina coalingensis* Cushman & Hanna, n. sp. Holotype, (figs. 10, 12) No. 2551; paratype, (fig. 11) No. 2552, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 221.


Figs. 16, 17, 18. *Gyroidina soldanii octocamerata* Cushman & Hanna, n. s. sp. Holotype, No. 2555, C. A. S.; from seven miles north of Coalinga, Calif.; Eocene, 10 feet above sandstone reef; p. 223.


All figures on this plate are enlarged approximately 50 diameters; see foregoing text for accurate measurements of the specimens. The carinate appearance of some of the figures is due to the method of engraving the plate.
IX

THE MAKING OF A SCIENTIFIC COLLECTION OF REPTILES AND AMPHIBIANS

BY

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I. THE COLLECTING

An institution which desires to make a collection of reptiles and amphibians such as the California Academy of Sciences has undertaken, and which has now grown to be one of the largest in the United States, will find that by far the best method of securing them is by sending its own collectors into the field. The collector must be active, observant, careful, enthusiastic, and tireless, if his efforts are to produce the best results. He must have some training and must be able to learn from experience, both his own and of others. The following suggestions are intended as a foundation upon which experience will enable him to build successful methods.

OUTFITTING

The character and amount of the outfit which the collector will require depend upon where he is going and how long he is to remain away from his base of supplies. On a long ex-
pedition, all of the articles in the following list may be needed, while on a shorter trip the first 15 may suffice.

1. Collecting pistol.  
2. Shot cartridges.  
3. Forceps.  
4. Strong cloth bags of various sizes from 3x6 inches up.  
5. Numbered tags.  
8. Pencils.  
10. Tin or aluminum pans.  
11. Alcohol.  
13. Containers: Tanks, jars, bottles, vials.  
15. Small tacks.  
16. Cheese cloth.  
17. String.  
18. Electric spotlight.  
20. Small ripping bar.  
21. Small hand ax.  
22. Skinning knives.  
23. Small saw.  
25. Salt.  
26. Powdered arsenic or arsenical soap.  
27. Alum.  
28. Tape measure.  
29. Shotgun.  
30. Cleaning equipment for firearms.  
31. Extra parts for firearms.  
32. Extra rubber gaskets for tanks.  
33. Formalin.  
34. Shipping tags and labels.  
35. Medical supplies.  
36. Bedding.  
37. Mosquito nets.  
38. Tent.  
40. Camera.  
41. Maps.  
42. Lists of species secured by earlier collectors in the same region.  
43. Barometer.  
44. Thermometer.  
45. Pocket compass.  
46. Field glasses.  
47. Canteen.  
49. Egg drill.  
50. Blow pipe.  
51. Whetstone.  
52. Pocket scales.  
53. Rifle.  
54. String.  
55. Fish hooks.  
56. Quarter-inch gimlet.  
57. Hypodermic syringe.

Securing Specimens

The various kinds of reptiles and amphibians differ so much in their habits of life and the places which they inhabit that the collector who inquires where he should look for them must be told “Everywhere except in the frozen regions of the far north and south.” Most amphibians and turtles are to be found in moist localities, but some inhabit the driest deserts. Many lizards and snakes prefer warm, dry localities, others are aquatic. Some kinds are active during the day and retire
long before dark. Others do their foraging during the twilight hours. Still others are nocturnal. Some species live in icy waters and are killed by moderate warmth. Others bask in the hottest sun. Some species have been found only in the tops of tall trees, others seem never to leave the ground and may spend most of their lives on its surface or in burrows. Some reptiles are found only on sand dunes, others only on rocks or boulders. Aquatic species may live in the sea, in lakes, rivers, small streams, springs, or subterranean waters. They may be purely aquatic, or they may spend more or less time ashore. Some kinds hibernate or aestivate during unfavorable seasons of the year. In general, it may be said that, local conditions being not unfavorable, the numbers of species and of individuals increase as one passes from the higher latitudes towards the equator. Ordinarily, they are most in evidence during the breeding seasons, usually in spring or after the rainy season, when plant and insect life are most abundant.

A great many kinds of amphibians and some reptiles may be caught easily with the hands. Others require various means of capture.

**Shooting** is the most effective means of securing most lizards, snakes and water frogs. The most convenient weapon is a 22-caliber, rim-fire target pistol with an eight or ten-inch barrel from which the rifling has been removed. Cartridges loaded with fine shot are used. They may be purchased in lots of five hundred or a thousand at a very reasonable price. Those loaded with chilled shot and smokeless powder are best. They are effective at ranges of from 10 to 30 feet. Large reptiles may require larger guns ranging from a 32-caliber pistol to a shotgun or rifle.

**Aquatic species** may often be shot along shore, or they may require the use of dip-nets.

**Forceps** which open and close like a pair of scissors may be purchased from dealers in taxidermists' supplies. They should be from 12 to 18 inches long, straight, and with blades not more than a quarter of an inch wide. The last inch or two of the inner surface should be rough or corrugated. With prac-
tice, one may become very expert in grabbing specimens with these forceps. Frogs at the bottom of a shallow pond may be seized, lizards may be pulled out of cracks and holes, and poisonous snakes may be picked up. Many lizards and snakes which are not poisonous will bite furiously. The larger species may tear the skin or even muscles of the hand. In such cases forceps will be found to be very useful.

_Fish hooks_, either curved or straightened, fastened to a wire or stick, may sometimes be used to spear specimens, or to pull them out of very narrow cracks. Turtles and frogs may often be caught with hook and line.

_A noose_ of wire, string, horse-hair, or other material, is sometimes of use, especially for obtaining specimens alive. Many lizards and snakes may be caught in this manner. Dr. Gadow states that crocodiles may be captured thus: "A long and strong rope is made into an easily slipping noose, with an opening of about 18 inches. The bait is attached to the upper part of the noose, while the lower portion is kept open by a springy branch, the whole thing being so balanced that it will float upright. When a crocodile seizes the bait, which it does with a side jerk of the head, the branch falls out of the noose and the latter closes around the upper or lower jaw".

_Traps_ set for mice and other small mammals sometimes catch reptiles and salamanders. Their systematic use for this purpose probably would not pay for the effort. Wells, and cattle guards on railways sometimes yield prizes. Freshwater turtles may sometimes be caught with submerged wooden traps, built on the general plan of a lobster trap and baited with meat or fish.

_Burrowing_ species often are turned up by the plow. A spade will sometimes reveal treasures where the soil is light enough to permit its use. Rare or unique specimens have been driven out of their burrows accidently when hot water or waste formalin have been thrown on the ground. Formalin has been used intentionally for this purpose, sometimes with good results. The method is worthy of development, perhaps with some of the irritating gases.
The successful collector, both literally and figuratively, *leaves no stone unturned*. Not only stones but everything loose should be turned over. Sticks, boards, rags, old tin cans, manure piles, logs, wood-rat nests, ant-hills, piles of débris, and old buildings, often conceal the most valuable specimens. Loose bark should be removed from trees and logs. Rotten stumps and logs should be torn apart. Hollow limbs and bamboo stems also afford hiding places. Vines and moss should be pulled off the trunks of trees and beds of moss on the ground investigated. This type of collecting is unquestionably the most productive.

*Night collecting* with a hand light is very effective. An electric spot-light or carbide search-light will be found to be about the best light to use. Geckos and other nocturnal lizards may be discovered on walls and rocks and tree trunks, or on the ground. Nocturnal snakes are often found, but this method of hunting is probably of greatest value in the securing of frogs and toads, particularly rare species which sing at night. These may be stalked with the light, advancing toward the supposed location of the frog as long as it continues to croak, and shutting off the light and pausing during the intervals of silence. Many species of tree frogs may be distinguished by their voices. The collector may by this method locate rare or unknown singers. When silence is too long maintained, an attempt to imitate the song of the frog will sometimes call forth an answer. Finally, the frog is seen glistening in the beam of light. It then usually may be caught without much difficulty.

Marine snakes sometimes will gather under an electric light hung over the water at night, and may be captured with a dip net.

The collector should endeavor to secure large series of all species which occur where he collects, for individual variation in reptiles and amphibians is very great. When his outfit will not permit the preservation of all of the material which he is able to secure, he should remember that the larger and more conspicuously colored kinds usually are more likely to have attracted the attention of earlier collectors than the small and inconspicuous species.
The first specimen secured of any species, even though it be only a fragment of a dried skin or skeleton, always should be preserved, at least until good specimens are obtained in the same locality.

The collector should carry with him, when hunting, a plentiful supply of small bags, and one or more large-mouthed bottles filled with alcohol (60%). Small amphibians should be placed in these bottles to prevent drying, and geckos and skinks to prevent breaking of their tails. Most other specimens, living and dead, may be placed in cloth bags. These may be carried in a fish creel or knapsack. Care should be taken in very hot climates not to crowd the specimens or the collector will find that they have already started to rot before he reaches his camp.

**LABELING THE SPECIMENS**

For purposes of scientific investigation a specimen without data is worse than no specimen at all. Still worse is a specimen with inaccurate data, for the study of such specimens often leads to wrong conclusions. The data which the collector is expected to supply for each specimen are:

1. A brief statement of where the specimen was collected.
   a. —Geographically.
   b. —Environmentally.
2. The date of collection.
3. Notes on habits or other interesting facts observed.
4. The source of the specimen when not originally found by the collector.
5. Some statement as to the kind of specimen; exact if possible; otherwise some general term such as frog, lizard, snake.

In order that there may be no confusion, each specimen must be labeled separately. For this purpose the collector is provided with a series of numbered tags. These tags are made of pure tin and are arranged consecutively on wires, each of which holds one hundred numbers. Each tag is provided with a string by which it is tied to the specimen. If the specimen has no limbs this tag may be tied about the body; otherwise, it is to be tied to the right fore-limb close to the
body. The strings must be drawn tight, tied securely with a square knot, and the surplus ends cut off. If these details are not observed a tag will sometimes become separated from its specimen, which is then valueless. Paper labels should never be used with specimens in fluid. A collector with his field tags arranged in this manner will save much valuable time in the field.

If for any reason it is necessary to insert a written label, write with lead pencil on a thin strip of wood, or with a steel point on a piece of sheet lead or pure tin. Skins on which salt has been used should never be labeled with tin or copper; a wooden or stamped leather label should be used.

A small, strongly bound record book should be provided. About four by six inches is a convenient size. This should be ruled into five columns on each two pages, and numbers corresponding to the tags furnished should be entered consecutively in the first column, thus:

<table>
<thead>
<tr>
<th>No.</th>
<th>Locality</th>
<th>Date</th>
<th>Kind</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2601</td>
<td>Tuscon, Ariz.,</td>
<td>May 8, 1921,</td>
<td>Frog</td>
<td>Santa Cruz River</td>
</tr>
<tr>
<td>2602</td>
<td></td>
<td></td>
<td>Tantilla</td>
<td>Santa Cruz River, under a</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>stone</td>
</tr>
<tr>
<td>2603</td>
<td></td>
<td></td>
<td>Thamnophis</td>
<td></td>
</tr>
<tr>
<td>2604</td>
<td></td>
<td></td>
<td>Sceloporus</td>
<td>In cactus thicket</td>
</tr>
<tr>
<td>2605</td>
<td></td>
<td></td>
<td>Uta ornata</td>
<td>In brush pile</td>
</tr>
</tbody>
</table>

Every precaution must be taken to prevent the loss of this book or its injury by water, rodents or insects. The records in it should not be made in ordinary ink. Either a water-proof ink (such as Higgins') or a hard lead pencil should be used.

An improved form of field record book provides a carbon copy of each page of entries. These carbon duplicates are to be removed from the book and mailed to the museum at frequent intervals, to guard against loss or destruction of the records.

A second note book should be provided, in which a journal is to be kept. In this should be set down, day by day, a record of events, a statement of the location and character of collecting grounds, extended notes on habits observed,—with reference by number to the specimens concerned,—descriptions of colors in life of individual specimens, and other matters of interest.
A small calendar should be securely fastened inside the cover of one or both of these books and the days should be crossed off as they pass.

**Preserving the Specimens**

The collector, having secured his catch and returned to his quarters, probably finds himself with a miscellaneous lot of specimens, living and dead. If any specimens are to be sent to the museum alive they must be set aside. The other living specimens should now be killed. This may be done by drowning them in alcohol. Sometimes it is best to kill snakes thus before removing them from the collecting bags. During the time needed to insure the death of these specimens, those brought in dead may be examined. Any blood adhering to them should be washed off with cold water. Specimens whose colors are to be described may be selected, and the various species secured should be segregated. Taking each specimen in turn, a numbered tag should now be tied to each specimen and the data entered after the corresponding number in the record book. Specimens requiring more extended notes in the journal may now be set aside until the others have been placed in the preserving fluid, but care must be taken not to allow amphibians to become dried, especially about the feet.

Large turtles and crocodiles and huge snakes must be skinned. All other specimens should be preserved in alcohol when it is possible to do so. The best commercial alcohol should be used. This is 93 or 95 per cent grain or ethyl alcohol. Alcohol preserves the specimens by drawing water out of their tissues, and by its antiseptic action. To preserve specimens well in alcohol certain rules must be observed. These are:

1. *The alcohol must have free access to the interior of each specimen*, in order that it may harden and preserve the tissues. For this purpose one or more cuts are made into the body cavity of the specimen, using a sharp knife or, better, a small sharp-pointed pair of scissors. These cuts should be from one-half to an inch or more in length, depending upon the size of the specimen. They should be made just to one side
of the median line on the lower surface of the body, except in turtles. If the specimen is a lizard, toad, frog, or salamander one opening usually will be sufficient, but snakes require a series of cuts at intervals of two or three inches. The region about the vent should not be injured. In turtles an opening should be made in front of each hind leg. Large reptiles may require additional slits in the side of the tail or in the backs of the thighs and arms. After the specimens have been placed in alcohol, one should make certain that the edges of the cuts have not stuck together, and any air which might prevent the entrance of alcohol should be pressed out of the body of the specimens.

2. — *Large masses of food or fat should be removed* from the specimen. The presence of a mass of animal food is a frequent cause of discoloration and decay at one or more points in an otherwise well-preserved snake.

3. — *The specimens should be put into alcohol soon* after they have been killed, to prevent drying and decay. They never should be left until the next morning.

4. — *The strength of the alcohol used must be adapted to the kind of specimen* to be preserved. Alcohol of full (95% strength may be used for snakes, turtles, crocodiles, and most lizards. Geckos and amphibians would in most cases be ruined by alcohol of this strength. Alcohol of about 65 to 75 per cent usually preserves amphibians and geckos well. After thorough preservation, amphibians and geckos should be kept in alcohol of 65 per cent; other reptiles in 70 to 80 per cent.

5. — *The quantity of alcohol used must be sufficient* to thoroughly preserve the specimens put into it. The alcohol draws water from the tissues of the specimens. If the mass of specimens is too great the alcohol quickly becomes too weak to do its work. The alcohol in which specimens are kept more than a day should never be permitted to fall below 55 or 60 per cent. Specimens should never be crowded until after they have been thoroughly preserved. They may then be packed in very little alcohol; just enough to cover them.
6.—*Hot weather delays and makes difficult the thorough preservation of specimens.* In the tropics they should be kept as cool as possible and must be carefully inspected every day until thoroughly preserved. If soft spots develop, additional cuts must be made, or alcohol may be injected with a hypodermic syringe. In large specimens it may be necessary to remove the viscera.

7.—*The shape in which specimens are hardened* is of much importance. Snakes should always be preserved in a simple coil. Turtles should have their heads extended and their mouths open. Lizards and salamanders should be hardened straight. The long tails of large lizards may be bent and laid forward alongside the body. When specimens are hardened in whatever shape they happen to assume they are less attractive, are much more difficult to study, and actually require greater expense for glass jars to hold them and alcohol to cover them.

The little additional time and care required to harden them in acceptable positions are more than paid for in increased satisfaction and lessened expense later. Specimens may be hardened most conveniently by placing them in proper positions in shallow pans, covering them with alcohol, and leaving them until their tissues have become firm. This usually requires from three days to a week. When one is collecting actively a number of pans will be needed, although more than one layer of specimens may be placed in a pan if care is taken to arrange them so that the alcohol has free access to all the cuts. The pans must, of course, be covered to prevent evaporation of alcohol. The specimens should be examined daily to see that all is going well. When they are found to be stiffened and thoroughly preserved they may be removed from the pans and placed in jars or tanks to await shipment. Snakes may be hardened in jars if rags, or better, whisps of excelsior are placed between the coils in such a way as to give the alcohol free access to the cuts.

Large pythons, boas, turtles and crocodiles should be skinned. Before skinning, the specimen should be stretched out straight and its length from the tip of the snout to the vent and from the vent to the tip of the tail and its girth at several stated points, measured and recorded.
Snakes often may be skinned through their mouths, turning the skin inside out without cutting it. Another way is to make a short longitudinal incision through the skin of the lower side of the neck just behind the head, free the skin, sever the soft tissues and spine from the skull and skin backward to the tail. By this method the skull is left in position. The skin is turned inside out. The skin may now be salted, rolled up, and dried (never in the sun), or it may be preserved in alcohol or brine. If small snakes are skinned, the head and tail should be left undisturbed. Specimens never should be skinned when it is possible to preserve them entire.

In skinning large turtles the usual procedure is to saw through each side of the plastron close to the bridge which joins it to the upper part of the shell. A knife cut joining the posterior ends of the two saw cuts is then made through the skin a little above the plastron. The plastron may now be raised, the viscera removed, the limbs, neck and tail skinned out, the whole inside of the skin and shell salted or rubbed with alum or arsenic, and dried. Excelsior or dried grass should be put in to prevent two layers of skin remaining in contact. The limbs and neck may be left, inverted, inside the shell and the plastron returned to its place. It is usually well to leave the limb bones attached to the skin at the toes, but all meat should be removed. It is necessary in large tortoises to make cuts along the under side of each limb, in order to skin to the toes. On the expedition of the California Academy of Sciences to the Galapagos Islands, all the giant land tortoises collected were soaked in a salt and alum pickle.

Crocodiles are skinned through a cut made through the lower surface from the neck well down the tail. Other cuts may or may not be necessary from this one along the lower surface of each limb. The skull and leg bones are cleaned and left in position. The skin is well salted, poisoned with arsenic, and is dried in the shade.

Formalin.—Many collectors prefer to use formalin instead of alcohol. Its use has some advantages and many objectionable features. It is easily transported, both reptiles and amphibians may be preserved in the same solution, and the careless or inexperienced collector who uses it will have less difficulty in preserving his specimens than if he uses alcohol,
for specimens placed in formalin never decay. On the other hand, in my judgment, formalin specimens never are as satisfactory as well prepared alcoholic specimens. They usually turn black or a dull leaden gray. Frequently they have a puffy swollen appearance and are very easily broken. Formalin is very irritating to the skin and eyes of those who use it. The tin labels attached to specimens hardened in formalin often are corroded, even years after the specimens have been removed to alcohol. Even the most ardent advocates of formalin say that specimens should be transferred from it to alcohol as soon as possible after they have hardened. In my opinion formalin never should be used when alcohol can be had and the collector can be induced to do something more than throw his specimens into the preservative.

Those who are addicted to the use of formalin say that only the best formalin (Schering's) should be used. It may be had in pint bottles. One pint will make 2 1/2 gallons of preservative. Three gallons of formalin are much easier to transport than a barrel of alcohol, but I repeat my firm belief that it is better to use alcohol whenever possible; and it usually is possible. Many herpetologists advocate the use of formalin for the first hardening of specimens, which they transfer to alcohol after a few hours, or days, or weeks in formalin. I have seen many specimens so preserved. In my opinion, they are always inferior to specimens which have been well preserved in alcohol alone.

Packing the Specimens

The specimens, having been thoroughly hardened and preserved, must be packed in jars, cans, or tanks, for storage or shipment. Many well prepared specimens have been ruined or seriously damaged through improper packing. This injury usually is brought about in one of four ways; pressure, friction, drying, staining.

Pressure.—Large, heavy specimens should never be packed with small, delicate ones. Large tanks never should be filled with small specimens, or packages of specimens, unless some means is provided to protect the lower layers of specimens
from the weight of the upper layers. Racks may be made of thin boards, or metal tubes or cans may be used inside the tanks. Small, delicate specimens may be put in vials or bottles. Wrapping specimens improperly in cheese-cloth often results in pressing them out of shape.

Friction.—Rubbing of the specimens against each other may wear off the scales or skin. This is most to be feared when transportation is by means of horses, mules, or other animals, but it sometimes occurs at sea, or in travel by automobile. It is best guarded against by placing specimens in small containers, by wrapping specimens loosely in cheese-cloth, or by putting excelsior with them in the containers, and by making sure that all containers are completely filled. In a tank partly filled with alcohol, specimens may be churned to pieces even if wrapped carefully in cheese-cloth.

Drying.—Alcoholic specimens which become dry are ruined. When specimens are to be shipped by express, unnecessary weight is to be avoided. Specimens which have been thoroughly preserved may be sent without any free liquid if packed in cheese-cloth or rags wet with alcohol. They must, however, be packed in such a way that the cloths will still be wet when they reach their destination. For long journeys this will require the soldering of any tins in which specimens are packed. Amphibians and geckos, as has been stated, will be damaged if placed in too strong alcohol.

Staining.—Ordinary cans, made of tinned iron, may rust and stain dull red specimens left in contact with them. Colored rags used for packing may stain specimens. Copper tanks used for collecting are coated inside with pure tin. If this coating is defective, the copper may stain everything green.

Exposure to light also injures specimens in alcohol. Their colors soon fade. They should be kept in the dark as much as possible. A few days exposure may cause considerable injury, and after prolonged exposure specimens become perfectly white.

April 22, 1927
Shipping the Specimens

Small packages from foreign countries may be sent by parcel post. Large, heavy shipments should be sent by freight, especially when they have to come by sea. Ordinarily, however, it is best and safest to forward specimens by express. Living specimens should always be sent by express, and must be packed in such manner as to comply with the requirements of the express companies. All packages should have full address. All packages from foreign countries should be sent in bond; otherwise, they may be opened at the Customs House, and specimens may be injured.

II. The Care of Collections in the Museum

In the first section of this paper I have endeavored to give suggestions which will enable collectors to secure specimens of scientific value and to send them to the museum in the best condition possible. The care which collections receive after their arrival at the museum is of great importance. Methods differ in various institutions, being governed largely by past usage and the ideas of the curator in charge. In this second section I shall try to set forth the methods which we have found most satisfactory in the California Academy of Sciences.

Care on Arrival

Immediately after their arrival at the museum all packages are opened and carefully examined.

Living specimens are put in jars and cages. Often they have been sent in alive for photographic purposes. Care is taken to keep their data with them so that no doubt as to their origin may arise.

Specimens which have been sent in wet rags are unpacked, placed in jars, and covered with old alcohol of suitable strength.

 Tanks or jars containing specimens in alcohol are opened, the strength of the alcohol is tested, and more added if necessary.
Specimens which have been preserved in formalin are soaked in water for two or three days, the water being changed several times each day. If the odor of formalin is still evident after this treatment, they require further change of fluid, but water is not used after this period. Instead, they are covered with old alcohol and this is changed once a week until the last of the formalin has been removed.

**Accessioning**

As soon as time permits the specimens are counted, checked on any lists which may have been received, and an accession slip is made out which states the number of specimens received and their origin. The specimens are then stored away in the dark until their turn arrives for labeling.

**Permanent Labeling**

At the very beginning it was decided that the usual method of labeling specimens in a reptile collection is not satisfactory. This, ordinarily, has been to attach to each specimen (or originally to each lot of specimens) a number printed usually on tin. These numbers were entered consecutively in a book or department catalogue where all data were recorded,—a system which is very inconvenient and which has led to many errors through duplication of numbers and in other ways.

It was decided to retain the Department Catalogue and the individual consecutive numbers on the tin label of each specimen, but to add to this label all essential data. A font of steel type and a small press were made to order, and each specimen has printed for it a tin label stating its serial number, the locality and date of collection, and the collector's name. The amount of time required to print these labels is not excessive and is more than made up later by elimination of the necessity for reference to the Catalogue each time the data are required. However, the greatest advantage is that the value of the collection cannot be destroyed by the loss of the Catalogue. Often, a lot of specimens have been collected in the same locality and by the same person during
the same month and year, so that a hundred or more labels may be printed with only minor changes in the type as first set. Frequently, the last figure of the number is left blank and stamped in later by hand. This often permits the printing of ten labels without any change of type, and another ten after the change of one figure. When frequent changes are necessary, progress is, of course, much slower.

The data are printed in two lines; number and locality in the upper line, and collector’s name and the date in the lower. The finished labels are about one-fourth of an inch in width and from one and one-half to three inches in length. They are printed on thin sheets of pure tin which has been cut into strips from 2½ to 3½ inches wide and a foot or two long.

The strings used for tying the labels to the specimens should be pieces of strong, heavy, linen thread, of the best quality, cut about seven inches long. They may be quickly prepared by winding the thread around a board three inches wide and half an inch thick and making one cut through all the thread so wound. The strings are passed through the holes in the labels and tied in such a way that each label hangs from a quarter or half inch loop in the middle of its string.

After a considerable number of labels has been prepared, the specimens are gotten out and, taking them one at a time, the field tag is removed. This number is compared with the list; the permanent number is found; the new label is selected, checked on the list, and tied securely to the specimen. As in the case of field tags, the permanent label is always tied to the right fore-limb close to the body, unless limbs are absent. In snakes and other limbless species the strings are tied around the body, usually at about the beginning of the second quarter of its length. The strings must always be drawn tight to prevent slipping and must be carefully tied. The ends are cut off a half inch beyond the knot. The specimens are then returned to alcohol and placed on storage shelves to await identification and study.

The field tags removed are saved, to be assorted and prepared for use again. This is done by replacing any missing tags, supplying each tag with a new string, threading them consecutively on copper wires, each of which holds 100 tags,
and sealing each loop of one hundred tags in an envelope. The envelopes are filed away in numerical order until needed for use. Each has printed on it the following notice:

DEPARTMENT OF HERPETOLOGY

FIELD TAGS Nos. ........................................
are contained in this envelope. If taken for use they must be removed from this envelope and the name and address of the person having same written below with date removed.

Name ........................................
Address ........................................

Date ........................................

CATALOGUING

Serial Catalogue.—The list which was used in labeling the specimens is now copied into the serial catalogue or register of the department. For this purpose, Higgins' waterproof India ink is used. This catalogue is a series of very strongly bound books, each of which holds the records of 6000 specimens. Each record occupies one line and extends across two pages. There are 30 records on each double page, of which there are 200 in each volume. The pages are ruled in vertical columns with printed headings, and in the first column are printed, one on each line, the numbers 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, repeated to the bottom of the page. These numbers become the last figure of the permanent serial numbers of the specimens, the other figures being entered in ink. They are an important feature, for they practically eliminate the possibility of duplication or omission of numbers. They also lessen the work of entry. It is convenient to have the same number of specimens recorded in each volume, for it makes it easy to find the volume containing any record sought.

In the various columns are recorded the permanent serial number, the name of the species, the sex, the locality where collected, the collector's name, the field or original number, the date of collection, the date when received at the museum, the character of the specimen (whether alcoholic, skin, skull, etc.), and additional remarks of interest. The name of the species
and the sex often are not entered until the collection is worked up and identified, which may be years later, but it is best to enter at least the generic name, if known, at the time the original entry is made.

After the record has been transcribed, it is carefully checked to see that no error has been made, and the name of the person who has done the cataloguing is signed at the top of the page.

*Card Catalogues.*—As specimens are entered in the serial catalogue more or less in the order in which they have been received, without regard to their relationship, some sort of index to the various species soon becomes necessary to enable one to find the records of all the specimens of any species. For this purpose card catalogues are used. This systematic card catalogue is based upon Boulenger's Catalogues, and like them is divided into five sections:

1. Tailed amphibians.
2. Tailless amphibians.
3. Turtles, crocodiles, etc.
4. Lizards.
5. Snakes.

Guide cards are provided for all the higher groups and for such genera and species as are represented in the collection. The arrangement followed is that of Boulenger, with such changes as are necessary to bring it to date, except that the species of each genus are arranged alphabetically. The generic guide cards are blue, the specific yellow, and the subspecific salmon. The last, however, may perhaps be abandoned, all subspecific names being treated in the same manner as specific ones, since such difference of opinion regarding their status may cause confusion.

All record cards are five by eight inches, or rather 125 by 201 millimeters. The cards are designed to keep a permanent record of all counts of scales, or other data, gathered in the study of the specimens. Much of a herpetologist's work consists in making and comparing counts of scales, pores, color bands, etc. These cards preserve these records and thus prevent repetition of this labor. Three kinds of cards are in use:
one for snakes, one for lizards, and one for all other kinds of specimens. They are all ruled alike, in columns with appropriate headings or spaces for headings. These headings differ on each of the three kinds of cards. The cards are filled in with a typewriter. Each card has space for the records of 14 specimens, below the two line heading. This heading consists of the name of the species on the first line, and the locality in full on the second line. In order to render comparison easy, specimens from different localities are never entered on the same card. Each new locality for a species calls for a new card (or more if more than 14 specimens are at hand).

These cards are not made out until the specimens have been studied and identified and are about to be installed in the main collection. At the same time that these cards are filled out, the names and sexes are entered in the serial catalogue, and the specimens are permanently bottled ready for the shelves. The card record is then checked with the book record, to catch any errors.

A second card catalogue, known as the geographical catalogue, is provided to show all species which the collection has received, listed by countries, states, counties, and other divisions, such as island groups.

There is also a card catalogue of type specimens.

**Glass Jars and their Labels**

All alcoholic specimens are kept in glass jars. Two types of jars are used. The largest sizes used are of the type known as Museum Jars. These are provided with covers which fit down on rubber gaskets. All smaller sizes, up to 6 x 15 inches, are of the other type known as Specimen Jars, and have glass stoppers, carefully ground in. Jars smaller than 2½ x 3½ inches should not be used, because of the danger of evaporation when so small a quantity of fluid is held. It is a matter of economy to keep on hand a good stock of jars of various sizes so that the proper size may always be selected for use. Jars should always be washed before use, even though they appear clean.

In bottling specimens the rule is separate jars for each species, and locality. Subject to this rule, one jar may hold
one specimen or fifty. However, it is best not to risk all of one species in one jar, because of the danger of evaporation.

When the specimens have been placed in proper jars the latter are filled to the neck with new alcohol of suitable strength,—75° to 80° for reptiles, except geckos, and 65° to 70° for geckos and amphibians.

The jars are now ready to receive their labels. These are made of strong white paper and are 7/8 of an inch wide and 5½ inches long. A heavy black line near each of the four edges forms a simple border, and two dotted lines, running lengthwise, divide the space inside the border into three equal parts. The finished label consists of three typewritten lines occupying these three spaces. In the upper space are written the serial numbers of the specimens and the name of the species; in the middle space, the locality in full; and in the lower space, the collector’s name, at the left, and the date, at the right. The result is a label which is simple, neat, and attractive.

Various methods of fastening these paper labels to the jars have been tried. That described below is the only one which has been found satisfactory. Strips of the same white paper used for the labels are purchased cut 7/8 of an inch wide and 18 or more inches long. The width of these strips is the same as that of the labels, and is determined by the height of the necks of the jars. One of these strips is placed about the neck of the jar and cut so that the ends overlap shortly, it is then moistened so that it will shrink tight, a little Le Page’s Glue is applied to one end of the strip, the band is tightened about the neck of the jar and is securely held there by the glue, which soon hardens. The ends of the label are then glued to this paper band in such a position that the splice in the band is hidden by the label. The label then fits the neck of the jar snugly, and is neat and secure.

**Installation**

The jar having been thus labeled, and its contents having been duly catalogued as described, the specimens are now installed in their proper places in the collection and their cards are filed in the card catalogue.
The collection is arranged systematically, and, like the card catalogue, follows the arrangement adopted in Boulenger's Catalogues, except that the species of genera are arranged alphabetically. When large series of a single species are at hand the jars are sorted alphabetically by countries, states and counties of origin.

Types and specimens prepared as dried skins are not installed with the main alcoholic collection. They are kept in separate rooms, but their position is indicated in the systematic collection by the installation in the proper place of one empty labeled jar for each type and for each species not otherwise represented. The labels on the jars for types are written in red ink. Cotyopes, paratypes and topotypes receive no distinctive treatment other than a notation in the catalogue.

Cases and Shelving

In some museums alcoholic collections are kept upon steel shelves arranged in stacks, very much as book shelves are arranged in the stack-room of a library. Metal shelving, of course, lessens the fire risk, but is very expensive. Where expense is not a matter of consequence metal should be used. Where expense must be considered, as was the case with us I am of the opinion that well built wooden shelving is just as satisfactory. The alcohol is so much more inflammable than wood that, after a fire once was started, it would be of no consequence whether the shelving were of wood or steel. It is conceivable that metal shelving might possibly prevent the starting of a fire where wooden shelving might permit it, but this must be a rare contingency and little to be feared. The greatest danger is of fire spreading from some other part of the building and creating sufficient heat to cause rapid vaporization and ignition of the alcohol.

After much consideration and experiment, it was decided to have shelves which are not adjustable. The distance between all shelves is the same, 15½ inches clear, and is intended to receive jars up to 15 inches in height. All shelves are of uniform width, 13 inches, being governed by the diameter (six inches) of the largest specimen jars. The lowest shelf in all sections may be removed to give sufficient height for the largest museum jars, if desired. Upright supports, of full
width boards, at intervals of three or four feet, divide the shelves into sections. Such shelving covers all the available wall space, from floor to ceiling. The rest of the floor space is occupied by the necessary aisles and by a series of stacks each of which is composed of two sets of the same sort of shelves built back to back. The outer edge of each shelf is provided with a half inch wooden ledge to prevent jars from rolling off, and a light wooden bar extends across from upright to upright a few inches above each shelf. These bars are held in position by brackets, and are easily removable. Both ledge and bar are intended to guard against earthquakes. Some of the museums in our eastern cities would do well to provide similar protection, for as their collections are now arranged a shock much lighter than that which surprised Charleston would put practically their whole collections on the floor in a sea of alcohol and broken glass.

Although all jars are labeled, a small typewritten label in a brass holder on the edge of each shelf is a great aid in finding specimens when wanted.

The gigantic tortoises and other large skins are kept upon wooden shelves of suitable dimensions in another room.

Type specimens, small skins, bones and other anatomical specimens, and the collection of amphibian and reptile eggs, are kept in wooden cases. These cases measure 21 1/4 inches wide, 26 inches deep, and 6 feet 1 inch high. They are provided with adjustable drawers the inside measurements of which are 1 1/4 x 15 9/16 x 22 3/4 inches. The wooden doors are not hinged, but are removable and fit against rubber packing to make them dust and insect proof. All specimens which are being labeled or studied are kept in such cases when not actually in use, until they are returned from the laboratory to the general alcoholic room. This is to protect them from unnecessary exposure to light.

The Collection Rooms

The room in which the alcoholic collections are stored is designed to protect its contents against fire, light, dust, moisture, and changes of temperature.

The room is built without any windows. There is no possibility of day light being carelessly allowed to enter and cause
fading of the specimens. Electric lights are provided between all stacks. The switch which controls them is located in the hall outside the alcohol room to prevent any possibility of a spark causing an explosion in case of accumulation of alcohol vapor through neglect of ventilation. An electric fan forces air from the room to a vent above the roof. The absence of windows also lessens changes in temperature and reduces the amount of dust and moisture which might enter. The room remains cool on our warmest days. Dust and moisture do little actual harm except to paper labels, but day light ruins specimens, which eventually turn white, and warmth increases the evaporation of the alcohol. Dust and moisture, however, would soon result in the destruction of skins, such as those of the giant tortoises stored in a similar special room. These specimens have to be guarded from the ravages of moulds as well as insects. The room in which they are stored is provided with steam radiators as an aid to dryness, and is (or was planned to be) air tight in order that the specimens in it might be fumigated without removal. An electric fan is provided for drawing off the fumes after fumigation.

**Rules, Principles and Policies**

In conclusion, I wish to state a few other points which, in one way or another, bear upon the formation and care of our collection. I say our collection because needs and policies will vary in each institution which gathers reptiles and amphibians.

*Types.*—All type specimens are kept by themselves in a special room. The great San Francisco fire of 1906 showed that it is unwise to keep types in their systematic positions in the general collection, as was done prior to that conflagration. All the types could then have been saved had they been segregated. As it was, time was not sufficient to permit the finding of all of them, and a number of types had to be left to burn. Since then, all types are kept in a light-proof case in a room which day light enters. In case of fire, they could be rescued in a very few moments.

Each type receives a second tin label which states that it is the “Type of *Uta stellata*”, or whatever name was given it. In
the last column of the serial catalogue, the word "Type" is written with a reference to the original description.

**Loans.**—It is desired to make the collection of the greatest possible use to serious students of reptiles. Certain rules regarding the lending of specimens are, however, necessary to safeguard the collection. Some of these rules are:

1. No type will be lent under any circumstances.
2. No unique specimen will be lent.
3. Specimens may be lent to institutions, not to individuals.
4. Loans may be made only when approved by the Director.
5. All specimens must be returned to this institution within a reasonable period, which shall never exceed six months.
6. Institutions which do not conform to this rule, or which permit specimens to be damaged by light or otherwise, may be refused further loans.
7. Institutions which borrow specimens will be expected to pay transportation charges.
8. When loans are made a complete list of the specimens must be made in triplicate, stating the serial numbers and the names of the species (if known). One copy shall be retained in the Department files. Two copies shall be sent to the institution borrowing the specimens, one copy for its use and one to be signed by it as a receipt and returned to the Academy.

**Exchanges.**—All exchanges of specimens shall be approved by the Director of the Museum. Except under most extraordinary circumstances, no exchange will be considered which would reduce the Academy's series of a species below 10 specimens. In the case of very variable or closely related species or subspecies, 40 specimens shall be the lowest limit, and it often will be desirable not to make exchanges even when these limits are exceeded. This is because the scientific value of a collection of reptiles and amphibians depends very largely upon the size of its series, which alone enables one to learn the limits of individual variation. It is much more important to preserve the series intact than to secure additional species at their expense.

All specimens which are removed from the collection and exchanged have added to their records in the serial catalogue and card catalogue a note to that effect. They are also entered in a special volume entitled "Catalogue of Specimens Ex-
changed, Destroyed or Lost". This book is intended to show
all specimens permanently removed from the collection.

Inspection of collections.—All dried skins and carapaces,
etc. are inspected at frequent intervals. If little piles of dust
under them indicate the presence of boring beetles, or if any
signs of the ravages of other insects are found, fumigation or
a gasoline bath is called for.

Inspection of the alcoholic collections is also necessary to
prevent damage. Alcohol will evaporate even from the best
made jars. No jars smaller than \(2\frac{1}{2} \times 3\frac{1}{2}\) inches should be
used, as it has been found that smaller sizes do not hold
enough alcohol to be safe without too frequent refilling.

Once every four years the entire collection should be gone
over jar by jar, and all evaporated alcohol replaced with new
alcohol of full (95\%) strength. Diluted alcohol should never
be used for this purpose. The specimens are originally bottled
in 65 and 75 per cent alcohol. Very little of the water in these
solutions evaporates. As evaporation proceeds the solutions
become weaker. If 65 or 75 per cent alcohol were used in
refilling jars the specimens eventually would be in water which
contained very little alcohol, and would, of course, be injured
or destroyed. Therefore, the rule is, use full strength for re-
filling. In the case of rare or delicate specimens it may be best
to test the strength of the solution with a hydrometer, or to
replace entirely the fluid in the jar with pure 65 or 75 per cent
alcohol.

Scope of the Collection.—The collection of reptiles and am-
phibians to be of greatest value, must aim to include all the
species of the world. In order that this may be eventually
accomplished, it is the policy of the Department to strive to
get, as soon as possible, those species which are likely to be-
come very rare or extinct. This includes, particularly, large
turtles and crocodiles, and many island forms. It is desired
to make the collection especially strong in its representation of
the fauna of the islands of the Pacific and the lands which
border on this ocean. Our field is, first, California; second,
western North America; third, the islands of the Pacific;
fourth, all lands adjacent to that ocean; next the western
hemisphere; and finally, the world.
Specimens as installed in the collection of the California Academy of Sciences
**NAME**

*Thamnophis ordinoides ordinoides* (Baird & Girard)

**LOCALITY** Crescent City, Del Norte Co., California

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**11438**

*Dromicus occidentalis*

Narborough Island, Galapagos Archipelago

J.R. Slevin  
April 10, 1906

Example of card catalogue and types of labels used in the Department of Herpetology, California Academy of Sciences
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THE BIRDS AND MAMMALS OF MODOC COUNTY, CALIFORNIA

BY

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INTRODUCTION

In ornithological and mammalogical literature touching upon the distribution of the birds and mammals of California, the small number of references to the northeastern part of the state seemed to warrant the assumption that a promising field for investigation lay in that quarter. With this idea in view, a reconnoitering trip was made to Modoc County in the spring of 1923, with Robert J. Wood as field assistant, in an endeavor to discover the most favorable localities in which to carry on observations and to collect desirable specimens supporting the distributional records made. The experience gained on this trip showed the possibilities existing in the region, and led to the planning of the more extended research that was carried on as outlined in the list of localities visited.

ITINERARY AND LOCALITIES VISITED

As so large a portion of this county is included in National Forest domain, it was decided that a good way to acquire needed information would be to keep in touch with the Forest Service stations, for the reason that the forest rangers are,
as a rule, intelligent, obliging and glad to assist in zoological work as far as may lie in their power. As was anticipated, these characteristics, together with the nature of their occupation and their knowledge of the country, made the friendly assistance offered by the rangers of much value to us.

Following out this policy in 1923, camps were made at the following Forest Service stations: Deep Creek (Surprise Valley), May 8 to 16; Buck Creek, May 16 to 31; Pit River, May 31 to June 4; and Jess Valley, June 4 to 15. During the visit to the Deep Creek Station, near Cedarville, the impression was created that there was not much of particular
interest to be found in that part of Modoc County, and, consequently, Eagleville, 15 miles farther south, with its nearby laguna, was not visited, and possibilities afterwards discovered to exist there were not then realized.

In the spring of 1924, Modoc County was visited again, the party this time consisting of Mr. Frank Tose, group artist and chief taxidermist of the Department of Exhibits, of the California Academy of Sciences, Jack Malloch, field assistant, and myself. Information acquired after the completion of the work in the previous year made it seem advisable to proceed first to Eagleville in order to try out that vicinity, and the result was that this place has since then been the headquarters for our Modoc County field work.

On this first visit to Eagleville, the party remained in the vicinity from May 22 until June 15. It had been the intention to reach Modoc County considerably earlier, but the party was unexpectedly detained on the way, not reaching its destination until rather too late to intercept much of the spring migration, yet a good deal was accomplished in spite of this setback. Camps were also made at the Buck Creek Forest Service Station, June 15 to 17, and at the Happy Camp Station, June 17 to 20, but at neither of these places did it appear to be profitable to make much of a stay at this season.

In order to learn more about the bird migrations in this part of California, Modoc County was visited in each of the three following autumns, each time with Eagleville as headquarters: In 1924, from September 3 to October 9, with Jack Malloch as field assistant; in 1925, from September 8 to October 16, with Jack Denver as assistant; in 1926, from August 28 to October 7, with Raymond M. Gilmore and Paul F. Covel as assistants, but on this occasion the first five days were passed at the Pit River Forest Service Station in order to pick up on the way some needed specimens.

Deep Creek Forest Service Station

Just inside the mouth of the Deep Creek cañon, at an elevation of 5000 feet and two miles southwest of Cedarville, Surprise Valley, lies the Deep Creek Forest Service Station. This cañon is long and narrow, running nearly east and west
and heading high up on the Warner Range, at that point over 7000 feet in altitude, and opening into Surprise Valley.

It is a relatively chilly cañon, as much of it is shaded by the mountains on the southern side for a large part of the year, especially in the fall, and did not prove to be favorable for our work, in spite of the fact that it was of quite diversified character, extending from sagebrush covered Upper Sonoran to high Transition, with brushy, rocky, and grass-grown areas scattered along its sides. Nor did the part of Surprise Valley in the vicinity of Cedarville appear to be very promising at the time of our visit. Rodent traps were set out in the neighborhood, but failed to bring in results; and birds were scarce, so that only a short stay was made here in the spring of 1923. On later visits to Surprise Valley, the Deep Creek cañon was several times gone over in the search for material worth recording, but without much success.

Buck Creek Forest Service Station

This station is placed at an altitude of 5300 feet on the southerly slope of the spur of the Warner Range forming the northern boundary of the Fandango Valley, and is about four miles east of the Willow Ranch Station of the Nevada, California, and Oregon Railroad running along the eastern shore of Goose Lake (altitude 4800 feet). On Willow Ranch is an extensive meadow, more or less swampy, with large willow thickets here and there, and the banks of Fandango Creek, flowing through the meadow, are lined in some places with a thick growth of cottonwoods.

The ranger station itself is on a slope thickly strewn with crumbled lava, overgrown with more or less forest where enough soil for tree growth has collected, and with sagebrush and other bushes in less favored areas. There is also a good deal of surface where the lava is too thick for the growth of vegetation, and which looks as if it had cooled only within the last few years. The forest of yellow pine and incense cedar extends in places out on to the floor of Fandango Valley, as does the lava and sagebrush, but there are small meadows near the station and upland meadows of greater extent farther up the valley. This is a well watered district, and there were more birds noted around the station itself than
in any place visited in 1923, but the avian population rapidly diminished in inverse ratio to the increase of the radius from this center, and birds were remarkably scarce in the surrounding country, in spite of its varied association and attractive appearance. Rodents also were scarce here, especially meadow mice and gophers, of which none was secured at this station. This, however, was evidently only a temporary condition as regards the rodents, particularly the meadow mice.

*Pit River Forest Service Station*

This station is situated nearly a mile north of the Pit River and some seven miles about west-southwest from Canby post-office in a small side valley opening into a meadow in the river bottom. Its altitude is about 4400 feet and the surrounding area is of the same sort of forest, lava, and sagebrush association as that of Buck Creek, and, in fact, of a great part of the plateau region of the county, but the meadows here are small and not very well watered.

During the reconnoissance of this place in 1923 not much of special interest seemed to develop, so but a short stay was made—from May 31 to June 4. There were one or two gophers here at the time, however, and the diagnosis of one specimen secured led to a second visit being made, for the purpose of further investigation, August 28 to September 1, 1926. Also, Gilmore and Covel were sent to the vicinity for a week at the end of September of that year with instructions to work the river banks, minks being especially desired.

*Jess Valley*

This valley lies six or seven miles southwest of the summit of Eagle Peak (9934 feet), the highest point of the Warner Range in California. Through the valley flow the streams that at its western end combine to form the South Fork of Pit River. The floor of the valley, at an elevation of over 5000 feet, consists of a slightly rolling meadow of some four square miles in extent, backed on three sides by mountains and shut in at its western end by a range of rocky hills cleft only by a narrow gorge through which the river flows, hemmed in on either side by massive dykes of lava. There
is a good forest of yellow pine, cedar, and fir partly surrounding the valley, and also a large amount of rough, lava-strewn territory, on which grows more or less sagebrush. In the valley bottom there are many willow thickets and some cottonwoods along the streams. In the lowest part, water stands over considerable areas of land, but whether this is a natural condition, or whether the standing water was only drainage from the irrigated meadows, I did not discover. Probably it was the latter. Waterfowl in limited numbers were apparently nesting in this submerged area, but for want of a boat it was not carefully examined. The birds noted here were practically the same as those to be found in similar territory elsewhere in the county.

**Surprise Valley and Eagleville**

As most of our field work was done in this valley, a rather more detailed description of this part of the county seems warranted. Surprise Valley lies on the eastern side of the Warner Mountain Range and extends from Mount Bidwell, which is three or four miles south of the Oregon state line, almost due south some 50 miles to a little beyond the northern boundary of Lassen County (California), with a width varying from four or five miles to seven or eight miles, reckoning between the bases of the hills on either side. Extending nearly the whole length of the bottom of the valley is a chain of narrow lakes, called Upper Lake, Middle Lake, and Lower Lake. They are merely sinks into which flows the water of the streams from the mountains flanking the valley, forming, in the rainy season, very shallow bodies of water. In dry seasons, when practically all of the stream flow is used for irrigating the meadow lands, the beds of the lakes are mostly expanses of alkali sand, so dry that it rises in clouds with every breeze, and over which whirlwinds may often be seen pirouetting in fantastic waltzes.

At only one place in the lakes do tules grow in sufficient quantities to become much of a factor affecting the bird life of the valley. This is at the south end of Middle Lake, around and in a clay-bottomed laguna, called Cameron Lake, which is shallow, but deeper than the rest of the main lake, and which contains water the year around in normal seasons.
its size varying with the time of year and the amount of rainfall from a small pond to an area of several hundred acres, at times becoming part of Middle Lake itself. In normal years it is a nesting ground for several species of water- and marsh-loving birds, and in the fall a resting and feeding ground for comparatively large numbers of wild ducks and other waterfowl. In places along some of the streams flowing into the lakes and around some small springs here and there in the meadows is also a limited growth of tules that gives nesting cover to some species of birds, but in no place is it of sufficient extent to have much effect upon the bird life.

A meadow lies along the western side of the lakes for nearly their whole length and extends around their ends, varying in breadth from a few hundred yards to over two miles, according to the contour of the foothills of the Warner Range. This meadow is irrigated from the small mountain streams crossing it, which are dammed as occasion requires and the water led through small ditches to spread over the gently sloping fields. This system, used very extensively in the meadows of Modoc County, makes possible the raising of much meadow hay and alfalfa, for feeding to livestock through the long winters, and, to some extent affects the local fauna.

Between this meadow land and the Warner Range there is a rolling plain, largely of land arable when cleared, that is covered with sagebrush and other Upper Sonoran plant growths, and from it the foothills rise abruptly. In fact, in some places along this western side of the valley the mountains rise so steeply that there are practically no foothills, and here the change from Upper Sonoran to Transition is almost startling.

The eastern side of Surprise Valley is a rolling plain, typically desert in character, partly rocky, in places covered with sand dunes; much of it is strewn with volcanic ejecta, and other areas are hummocky clay, swept bare by heavy winds, with sagebrush and thorny desert bushes scattered over all. This plain slopes gradually up until it merges into the foothills of the western Nevada mountains. It has a few small streams struggling across it, and springs, some hot and some
cold, occur along the lower levels. Some of the springs form good sized ponds or lagunas, where ducks and other waterfowl congregate, such as Boyd's Springs, northeast of Lake City, where the main pond must be about half a mile in length.

At the north end of Surprise Valley stands historic Fort Bidwell, noted as the headquarters of the United States troops during the Modoc Indian outbreak of 1873. The small settlement, where the Modoc Indian school is now located, was placed at the southern base of Mount Bidwell, which, from its height of 8551 feet, looks down upon the whole length of the valley. Mr. H. W. Henshaw passed some time here during part of his work on the Wheeler Geographical Survey in the field seasons of 1877 and 1878, yet there are but few records of specimens taken actually in the vicinity of Fort Bidwell, or even in any part of Surprise Valley. Most of the records published in the report of that survey (Henshaw, 1879) are general rather than specific in character, and a record often includes adjacent parts of the three states, California, Oregon, and Nevada.

Besides the three settlements already mentioned, there is another, Lake City, a mile or so west of the lower end of Upper Lake. This is a small place, noted as being productive of the best quality of fruit raised in the valley.

Eagleville, as before remarked, was selected as headquarters for the Academy field parties for most of the work done in the county, as it offered the best combination of associations that could be found, with the desert on the eastern side of the valley; the laguna (Cameron Lake) two miles east of the town, between the desert and the meadow land that extends up to the settlement itself; the large Upper Sonoran sagebrush area, here and there cleared for grain fields, that reaches to the base of the Warners; and the narrow belt of Transition, partly forested at the higher altitudes, merging into the limited area of Boreal Zone on the highest summits of the range.

In addition to the highway that runs north and south through the valley, there are roads, passable except in winter, that make a large part of this territory accessible from Eagleville; and within easy reach of that place apparently occur
nearly all of the species of land birds, and, in favorable seasons, also a large proportion of the water, shore, and marsh birds, to be found in the county.

**Meteorologic Conditions**

The number of adults of resident species of birds or mammals that survive the hardships of the winter season depends to a considerable extent upon meteorological conditions, and it is evident that the number of young raised depends largely upon the number of adults surviving at the time the breeding season begins. Moreover, since the migratory activities of certain species of birds are largely affected by abnormal weather conditions, it seems in place to say something of the meteorological conditions, particularly rainfall, during the years in which the Academy parties visited Modoc County.

The rainfall of California has been on a general decline for some 20 years past, with many seasons showing an amount of rain below normal, and but few showing any great rise above it. Figures are at hand from which can easily be computed the departures from normal of the central region of California, at the latitude of San Francisco, and, while these figures are not strictly applicable to the Modoc region, there is good evidence to show that similar general conditions prevailed there during the periods below mentioned.

For central California the total precipitation was practically normal for the 20-year period beginning with the rainy season of 1886-87, but the period from 1906-07 to 1925-26, inclusive, shows a relatively large deficiency, most particularly in its latter half. The totals of the departures for the whole of the latter of these two 20-year periods are, expressed in percentage form with normal at 100 per cent: above normal precipitation, 117 per cent; below normal, 355 per cent; balance 238 per cent less than normal, or, in other words, a deficiency in total rainfall for the 20 years of 51.6 inches. The latter half of this period, however, is principally responsible for this deficiency, the respective departures being 20 per cent and 221 per cent, leaving a balance on the wrong side of 201 per cent, or a deficiency of 42.4 inches for the 10 years ending with the season of 1925-26. The normal 21.7 inches
per annum, in these instances is the average of three stations in central California, which, of course, would not be the actual normal for Modoc County, but the departure percentages for the latter region would probably closely parallel those given here. In consequence of this deficiency of precipitation, the water table has been greatly lowered, the flow of springs and streams lessened and the lakes have had their water content sadly depleted. These conditions have had a very appreciable effect upon the fauna of the Modoc region, but it would take some years to discover to how great an extent.

Many ducks, cranes, and marsh birds breed in Modoc County when conditions are favorable, but some of the recent years have had so little rainfall that shallow lakes, and most of the lakes in this region are shallow, have dried up completely. Others have had so little water in them that the nesting activities of birds accustomed to breed there have been greatly impeded or rendered impossible. A good example of this condition was found in 1924, when Cameron Lake, usually containing water the year around and having meadows and swamps in close proximity, forming a good nesting ground, was reduced to a small area of foul mud with dead or dying tules on all sides, and the adjacent swamps were dry.

In that year of drought, Goose Lake was so low that the meadows at the south end, ordinarily teeming with ducks and marsh birds, had no bird life present at the time of our spring visit except a few ducks, terns, and phalaropes that were pitifully hovering around a little pond, a few yards in diameter, unable to realize that there was no other place for them to nest.

Of the years in which Modoc County was visited by Academy field parties, the rainy season of 1922-3 was about normal, except possibly for the very cold spring, several snowstorms occurring in May and June. Even then Goose Lake was evidently much below the normal water level, as shown by the lines of gravel wash on its shores, and the lakes in Surprise Valley were almost dry as early as May. The rainy season of 1923-4 was one of great drought, the lakes in Surprise Valley being quite dry early in the spring, and Goose Lake showing large areas of sandspits and islands that were not in evidence the year before. The rainfall of the
1924-5 season was again nearly normal, and Cameron Lake, the only one visited by the Academy party of the autumn of 1925, was quite a body of water. Upon its surface were hundreds of ducks, many of which had been raised there.

The next season was dry, though some late spring rains had helped out the farmers' crops, and the lakes and springs were drier than in the previous two years. The larger lakes in the northwestern part of the county were reported to be very low, and but few ducks and marsh birds could find places to breed. Strangely enough, the spring of 1926 proved to be a very favorable one for the nesting of some of the gallinaceous birds. The two species of quail were especially abundant in the fall of that year, and Sage Grouse were reported as being numerous during the open season for that species. Unfortunately these birds are liable to great losses in the winter time. If they are covered by a snowfall that changes to rain and is followed by a continued frost, the birds become frozen in and starve to death. It also happens that some spring seasons in this region are very wet, with occasional snowstorms occurring even well into June, and many broods fail to survive the ordeal.

That the weather in the fall affects the migration of birds was well exemplified in the case of jays and Gambel's Sparrows in the years 1924, 1925, and 1926, as shown in the text of the accompanying annotated list, the great numbers appearing in migration during the dry seasons proving that a well-watered route is the most popular one at such times.

Source of Materials

The lists of birds and mammals accompanying this paper are made up from the following sources: Available published records; through the courtesy of its director, Dr. Joseph Grinnell, field notes and specimens in the Museum of Vertebrate Zoology, University of California, Berkeley, California; notes and material obtained by field parties from the Department of Ornithology and Mammalogy, California Academy of Sciences; and, to a slight extent, reports of reliable resident hunters, the accuracy of whose statements in regard to certain well known species there seemed to be no reason to doubt.
During the field work of the Academy parties endeavor was made to secure as many of the species of birds and mammals of the region as possible, rather than to collect large quantities of material already well represented in collections. The number of birds collected within the actual boundaries of Modoc County was 735, and of mammals, 311, making a total of 1046 specimens taken by Academy parties. Banding of sparrows, practically all being Gambel's Sparrows (Zonotrichia leucophrys gambelii), was carried on in the fall of 1925 and 1926, when the numbers of birds banded were respectively 387 and 943, or a total of 1330.

Attention is called to the fact that the northwestern part of Modoc County was not visited by any Academy party, so that all records given for that region were made by others. Something always seemed to prevent our reaching that locality. Bad weather with consequent bad roads, the drying up of the lakes and water holes, or unfinished work in other places were the causes of this neglect. However, one of our parties had done some work in eastern Siskiyou County, very close to the border line of Modoc County, without discovering anything not found in or recorded from the latter county.

In spite of the earnest and constant search on the part of its compiler, Dr. Joseph Grinnell, there may yet be some published records applying to this region to which there is no clue in the Bibliography of California Ornithology (Pacific Coast Avifauna, Nos. 5 and 16). It seemed as if there should be available in Washington, D. C., some records to include in these lists of birds and mammals of Modoc County, but Miss M. E. McLellan, assistant curator of the Department of Ornithology and Mammalogy, very kindly made a search of the records and collections of the United States National Museum and the Biological Survey without discovering anything that does not appear in the accompanying lists.

The occurrence of certain birds and mammals (the generic identification, at least, being unquestioned) in Modoc County has been reported by residents and other observers, but the reports have not been supported by specimens, nor are there any specific published records. In such cases, the names have been placed in a hypothetical list for future substantiation or rejection, as the case may be.
Had the autumn visits of the Academy parties been extended later into the season, possibly a few more avian records might have been obtained, but, toward the middle of October so few birds linger in this part of the state, at an elevation from 4500 feet and upward above the sea, that it soon becomes impossible to find much ornithological work to do while waiting for the appearance of something worth recording. Some work could be done in securing specimens of mammals to support the statements of occurrence by residents, for mammals might be taken more readily after the snow falls than earlier in the season, but in carrying on such work a great deal of time and energy would have to be expended to accomplish what might prove to be relatively small results.

Moreover, there is no record of any systematic field work having been carried on in Modoc County in the winter time, so the accompanying lists, particularly the list of birds, are not presented as complete, but as a good basis upon which other investigators may wish to build as time goes by, as well as something by which future students may compare the present status of the bird and mammal life of this region with that of their generation.

The ornithological nomenclature employed in this paper is practically that of the American Ornithologists’ Union Check-List, of 1910, and the subsequent Supplements. In certain cases, however, where suggested changes seem sufficiently warranted by light recently thrown upon the subject, some departures have been made.

With increased practice on the part of experts in this line, the matter of subspecific differentiation is becoming so complicated that the average ornithologist or mammalogist cannot keep pace with production and seldom has an opportunity to familiarize himself with the subjects in question. In many of the more finely drawn cases that come before him, he must choose one of two courses—he must either blindly accept or reject the dictum of the describer, or he must leave in abeyance such cases as he cannot prove to be, or convince himself of their being, worthy of recognition. It is the latter course that has been pursued in this paper.
Acknowledgments

For assistance of various sorts and for many courtesies shown to me in the field and in the study, I am indebted to a number of individuals, so many that they cannot all be mentioned here.

This paper would have been only a report upon the observations made and the material secured in northeastern California by field parties from the Academy had it not been for the courtesy shown by Dr. Joseph Grinnell, Director of the Museum of Vertebrate Zoology, University of California. In the early part of the field work, I took some specimens to the Museum of Vertebrate Zoology for comparison. Dr. Grinnell was kind enough to place at my disposal all the museum's specimens and notes pertaining to the Modoc region, and to suggest that I include in my report all the information that could be gathered from this source. There is in that museum much material from Modoc County, the greater part having been secured by a field party that collected specimens and kept journals of observations during an expedition to this territory in 1910, when work was carried on from late May until early August. At this time a cross section survey was made of the bird and mammal life of the country lying between Goose Lake and Cedarville, Surprise Valley, when camps were established at intervals from the lower levels to the summit of the Warner Range. This party was composed of three zealous young fellows just entering the zoological field. Since that time two of them, H. C. Bryant and W. P. Taylor, have followed up zoological work in special directions and become well known in their particular lines of endeavor. At the time of the Modoc expedition, the members of the party were new to the work, and in cases where there might arise question as to their identification of species their manuscript records have not been used.

In addition to the advice and practical assistance given by Doctor Grinnell whenever it was sought, I take pleasure in acknowledging my indebtedness for aid and information to the following individuals: to Messrs. H. S. Swarth and Joseph Dixon, and other members of the Museum of Vertebrate Zoology staff, who have ever been ready to lend a helping hand in diagnosis of material and in other ways; to Miss
M. E. McLellan, assistant curator, Department of Ornithology and Mammalogy of the California Academy of Sciences, for the part taken by her in the preparation of this paper; to Messrs. James A. and Frederick Street, managers of the general store in Eagleville, who have been much interested in our work and who have assisted us in many material ways, giving much valuable advice concerning the locality, and, as experienced hunters of wild game in Modoc County, imparting much information touching upon the bird and mammal life that has come under their observation; to Mr. F. A. Nolan, owner of the old hotel building in Eagleville, who kindly allowed our parties to occupy the building, free of charge, for three successive visits; to residents of Eagleville and vicinity, who have been interested in our work, allowing us to collect on their premises, often bringing us material of much value, and aiding us in many practical ways; to Forest Rangers Ben. Johnson, at that time in charge of the Deep Creek Station, Lawrence Smith, of the Buck Creek Station, and Ivan Cuff, of the Pit River Station, all of whom received us most hospitably and helped us in every way possible. Acknowledgments are due to Mr. Frank Tose, group artist and chief taxidermist of the Department of Exhibits of the Academy, who accompanied me to Modoc County in the spring of 1924 and who was indefatigable in his search for new and interesting records, and also to the field assistants who cheerfully responded to every call, irrespective of hour or day, the names of whom are mentioned in the list of places visited.

**Check-List of the Birds**

1. *Echmophorus occidentalis* (Lawrence)
2. [See footnote, page 278]
3. *Colymbus nigricollis californicus* (Heermann)
4. *Larus californicus* Lawrence
5. *Larus delawarensis* Ord
6. *Larus philadelphia* (Ord)
7. *Sterna caspia imperator* (Coutes)
8. *Sterna forsteri* Nuttall
9. *Chlidonias nigra surinamensis* (Gmelin)
10. *Phalacrocorax auritus* subspecies
11. *Pelecanus erythrorhynchos* Gmelin
12. *Mergus americanus* Cassin
13. *Lophodytes cucullatus* (Linnaeus)
14. *Anas platyrhynchos* Linnaeus
15. *Mareca americana* (Gmelin)
16. *Nettion carolinense* (Gmelin)
17. *Querquedula cyanoptera* (Vieillot)
18. *Spatula clypaca* (Linnaeus)
19. *Dafila acuta tsitsihoa* (Vieillot)
20. *Marila americana* (Eyton)
21. *Marila valisineria* (Wilson)
22. *Marila marila* (Linnaeus)
23. Morula affinis (Eyeton) 63. Accipiter cooperi (Bonaparte)
24. Marila collaris (Donovan) 64. Astur atricapillus striatulus (Ridgway)
25. Charitonetta alboca (Linnaeus) 65. Buteo borealis calurus Cassin
26. Erismatura jamaicensis (Gmelin) 66. Buteo swainsoni Bonaparte
27. Chen hyperboreus hyperboreus (Pallas) 67. Archibuteo ferrugineus (Lichten-
28. Anser albiros or albiros (Scopoli) stein)
29. Branta canadensis canadensis (Linnaeus) 68. Aquila chrysaetos (Linnaeus)
30. Branta canadensis minima Ridgway 69. Halicoccus leucocophalus leucoce-
31. Cygnus columbianus (Ord) phalus (Linnaeus)
32. Plegadis guarauna (Linnaeus) 70. Falco mexicanus Schlegel
33. Botaurus lentiginosus (Montagu) 71. Falco columbarius columbarius Linnaeus
34. Ardea herodias hyperonca 72. Cerchncis sparveria sparveria (Linnaeus)
Oberholser 73. Pandion haliaetis carolinensis (Gmelin)
35. Chasmerodius egretta (Gmelin) 74. Tyto alba pratincola (Bonaparte)
36. Nycticorax nycticorax nycticorax (Boddart) 75. Asia wilsonianus (Lesson)
37. Grus canadensis (Linnaeus) 76. Bubo virginianus occidentalis Stone
38. Grus mexicana (Müller) 77. Sterna hirundo hypoga (Bonaparte)
39. Porzana carolina (Linnaeus) 78. Glaucidium gnomon subspecies
40. Fulica americana Gmelin 79. Ceryle olivacea courina Grinnell
41. Lobipes lobatus (Linnaeus) 80. Dryobates villosus orius Oberholser
42. Steganopus tricolor Vieillot 81. Dryobates phaeocercus homorus
43. Recurvirostra americana Gmelin Cabanis & Heine
44. Himantopus mexicanus (Müller) 82. Xenopius albicoloratus albicolora-
45. Gallinago delicata (Ord) tus (Cassin)
46. Piscina minuta (Vieillot) 83. Picoidea arctica (Swainson)
47. Limosa fedoa (Linnaeus) 84. Sphyrapicus varius nuchalis Baird
48. Totanus melanoleucus (Gmelin) 85. Sphyrapicus varius daggettii
49. Catoptrophorus semipalmatus Grinnell
inornatus (Brewster) 86. Sphyrapicus thyroides (Cassin)
50. Actitis macularia (Linnaeus) 87. Asyndemus lewisi Riley
51. Numenius americanus Bechstein 88. Colaptes cafer collaris Vigors
52. Oxycychus vociferus vociferus 89. Phalaeoptila nutallii nutallii
(Linnaeus) (Aulubon)
53. Charadrius nivosus (Cassin) 90. Chordeiles virginianus heperis
54. Gregoryx picta plumifera (Gould) Grinnell
55. Lophotyto californica valicola (Ridgway) 91. Archilochus alexandri
(Ridgway) (Bourcier & Mulsant)
56. Dendragopus obscurus sierra 92. Selasphorus rufus (Gmelin)
Chapman 93. Steilula calliope (Gould)
57. Pediacetes phasianellus colum- 94. Tyrannus tyrannus (Linnaeus)
bianus (Ord) 95. Tyrannus verticalis Say
58. Centrocercus urophasianus 96. Myiarchus cinnascens cinnascens
(Bonaparte) Lawrence
59. Zenaidura macroura marginella 97. Sayornis saya (Bonaparte)
(Woodhouse)
98. *Nuttallornis borealis* (Swainson)
99. *Myiochanes richardsonii richardsonii* (Swainson)
100. *Empidonax difficilis difficilis* Baird
101. *Empidonax traillii traillii* (Audubon)
102. *Empidonax hammondii* (Xantus)
103. *Empidonax wrighti* Baird
104. *Empidonax griseus* Brewster
105. *Otocoris alpestris merrilli* Dwight
106. *Pica pica hudsonia* (Sabine)
107. *Cyanocitta stelleri frontalis* (Ridgway)
108. *Aphelocoma californica-inturnanis* Grinnell
109. *Perisoreus obscurus griseus* Ridgway
110. *Corvus corax sinuatus* Wagler
111. *Corvus brachyrhynchos hesperis* Ridgway
112. *Nucifraga columbiana* (Wilson)
113. *Cyanoccephalus cyanoccephalus* (Wied)
114. *Dolichonyx oryzivorus* (Linnaeus)
115. *Molothrus ater artemisii* Grinnell
116. *Xanthocephalus xanthocephalus* (Bonaparte)
117. *Agelaius phoeniceus nevadensis* Grinnell
118. *Agelaius tricolor* (Audubon)
119. *Sturnella neglecta* Audubon
120. *Icterus bullockii* (Swainson)
121. *Euphagus cyanoccephalus cyanoccephalus* (Wagler)
122. *Hesperiphona vespertina montana* Ridgway
123. *Carpodacus purpureus californicus* Baird
124. *Carpodacus cassini* Baird
125. *Carpodacus mexicanus frontalis* (Say)
126. *Astragalinus psaltria hesperophilus* Oberholser
127. *Spinus pinus* (Wilson)
128. *Passer domesticus* (Linneaus)
129. *Poecetes gramineus confinis* Baird
130. *Poecetes gramineus afinis* G. S. Miller
131. *Passerellus sandwichensis alaudinus* Bonaparte
132. *Passerellus sandwichensis nevadensis* Grinnell
133. *Chondestes grammacus strigatus* Swainson
134. *Zonotrichia leucophrys leucophrys* (J. R. Forster)
135. *Zonotrichia leucophrys gambelii* (Nuttall)
136. *Zonotrichia coronata* (Pallas)
137. *Spizella passerina arizonae* Coues
138. *Spizella breweri Cassin
139. *Junco oreganus thurberi* Anthony
140. *Amphispiza bilineata deserticola* Ridgway
141. *Amphispiza nevadensis nevadensis* (Ridgway)
142. *Melospiza melodia fallax* (Baird)
143. *Melospiza melodia fisherella* Oberholser
144. *Melospiza lincolnii lincolnii* (Audubon)
145. *Passerella iliaca schistacea* Baird
146. *Passerella iliaca sinuosa* Ridgway
147. *Passerella iliaca altivagans* Riley
148. *Passerella iliaca fulva* Swarth
149. *Pipilo maculatus curtatus* Grinnell
150. *Oberholseria chlorura* (Audubon)
151. *Hedymeles melanocephalus capitalis* Baird
152. *Passerina amana* (Say)
153. *Piranga ludoviciana* (Wilson)
154. *Petrochelidon lunifrons lunifrons* (Say)
155. *Hirundo erythrogaster* Boddaert
156. *Iridoprocne bicolor* (Vieillot)
157. *Tachycineta thalassina lepida* Mearns
158. *Bombycilla cedrorum* Vieillot
159. *Lanius ludovicianus excubitorides* Swainson
160. *Vireosylvia gilva swainsonii* (Baird)
161. *Laniivireo solitarius cassini* (Xantus)
162. *Vermivora rufulcapilla gutturalis* (Ridgway)
163. *Vermivora celata lutescens* (Ridgway)
164. *Dendroica aestiva breweri* Grinnell
165. *Dendroica auduboni auduboni* (J. K. Townsend)
166. *Dendroica nigrescens* (J. K. Townsend)

April 27, 1927
General Account of the Birds

1. Aëchmophorus occidentalis (Lawrence). Western Grebe

A large number nesting on Clear Lake (Finley, 1911, p. 348); three seen at Goose Lake, June 12, 1912 (Dawson, 1916, p. 23); Clear Lake in early April, 1918 (Willet, 1919, p. 195); Tule Lake, a few seen on May 18, 1918 (Grinnell, MS). Evidently a common bird during spring and summer and probably resident to some extent.

3.¹ Colymbus nigricollis Californicus (Heermann). Eared Grebe

Speaking of this species, Henshaw says: “In Nevada, Oregon and California it is by far the most numerously represented of the family, and may be found at the right season on any and all of the lakes of this region where exist the proper nesting facilities” (Henshaw, 1897, p. 2312). Occurs on

¹ The species originally entered as number 2 is omitted from list, as evidence of its occurrence has finally been deemed insufficient to warrant its inclusion.
many of the lakes along the east side of the Sierras (Grinnell, 1915, p. 16). Yet, in spite of these statements of general distribution, this bird was unknown to the duck hunters of Surprise Valley.

On October 12, 1925, Mr. James A. Street, with some companions, hunting at Cameron Lake, shot half a dozen birds that were strange to them. One of the birds was brought to me for identification and proved to be a male Eared Grebe. On October 1, 1926, several of these grebes were found on one of the two ponds at Menlo Baths, four miles south of Eagleville, and five of them were secured for the Academy collection, all being immature birds.

4. *Larus californicus* Lawrence. California Gull

Occurs in summer on the larger lakes of northeastern California (Grinnell, 1915, p. 22). Breeding at Clear Lake (Finley, 1911, p. 348). Numbers, estimated at 1800, were noted at Clear Lake on April 10, 1918 (Willett, 1919, p. 196). One individual, in poor condition, was taken near Eagleville by the Academy party on May 28, 1924.

5. *Larus delawarensis* Ord. Ring-billed Gull

About 200 were noted at Clear Lake on April 10, 1918, among the *Larus californicus* that were assembled on the breeding grounds there (Willett, 1919, p. 196). This date was too early for nesting, but as this species breeds in numbers at Malheur Lake, Oregon, not far north of Clear Lake with, but not among, the *Larus californicus*, there is good reason to believe that it nests at Clear Lake, also.


Three immature birds were noted at Goose Lake on June 20, 1912 (Dawson, 1916, p. 24).

7. *Sterna caspia imperator* (Coues). Caspian Tern

“A company of some twenty birds” was noted on Goose Lake, near the mouth of Davis Creek, June 12-24, 1912.
(Dawson, 1916, p. 24). No definite signs of nesting, however, were observed. Noted at Tule Lake, June 10, 1918, by Dr. B. W. Evermann (MS).

8. **Sterna forsteri** Nuttall. Forster's Tern

Summer visitant. On May 21, 1923, this species was noted at Willow Ranch where a few pairs were nesting on the small laguna near the railroad station. Also seen by the Academy field party in May, 1924, on the fast drying-up laguna two miles east of Eagleville where two or three pairs apparently were trying to find a suitable nesting ground. They did not succeed, however, as the drought had diminished the laguna to a mere puddle.

9. **Chlidonias nigra surinamensis** (Gmelin). Black Tern

Recorded as breeding at practically all of the lakes northeast of the Sierras (Grinnell, 1915, p. 25). Fresh eggs were secured by Dr. Barton Warren Evermann at Alturas Meadow, June 9, 1918. Birds of this species were seen by Academy parties in Jess Valley in June, 1923, and in Surprise Valley, in May, 1924.

10. **Phalacrocorax auritus**, subspecies

Nesting at south end of Tule Lake in 1895 (Finley, 1907, p. 36, photograph). Breeding on islands in Clear Lake, April 10, 1918, when about 100 pairs were noted, with many nests completed and some containing one or two eggs (Willett, 1919, 197). Mr. Willett remarks in his paper that he could not distinguish, even at short range, distinctive white nuptial crests on the heads of these cormorants and that, as no specimens have been secured for identification, he believes that there is a possibility of error in regard to the subspecies to which the cormorants of northeastern California have been ascribed.
11. **Pelecanus erythrorhynchos** Gmelin. White Pelican

Recorded as breeding at Tule Lake (Finley, 1907, p. 37). “From four hundred to five hundred pairs noted on islands at Clear Lake April 10 [1918]. At this date about one hundred and fifty nests were noted, many of which contained one or two eggs each” (Willett, 1919, p. 197). Reported by settlers to be very numerous in Surprise Valley at times when the lakes are full of water, in spite of the fact that there can be but few, if any fish there to serve them as food. I found the remains of one individual, killed in the previous winter, hanging on a fence near Eagleville, September 15, 1924.

12. **Mergus americanus** Cassin. Merganser

Eleven birds seen at Clear Lake in early April, 1918 (Willett, 1919, p. 198).

13. **Lophodytes cucullatus** (Linnaeus). Hooded Merganser

One noted at Clear Lake on April 5, 1918 (Willett, 1919, p. 198).

14. **Anas platyrhynchos** Linnaeus. Mallard

Breeds in practically all suitable places in the county. Abundant on the laguna near Eagleville in the fall of 1925.

15. **Mareca americana** (Gmelin). Baldpate

Breeding at Davis Creek in June, 1912, when two sets of eggs were taken, and noted in Surprise Valley in July of that year (Dawson, 1916, p. 24). Taken in Surprise Valley in the fall of 1926 by Academy field parties. Common during migrations according to local duck hunters.

16. **Nettion carolinense** (Gmelin). Green-winged Teal

Breeding at Clear Lake (Finley, 1911, p. 348). On several occasions in September, 1924, small numbers of this teal were noted in Surprise Valley by the Academy party. It was much
more numerous there in the fall of 1925, as the bodies of water were then of good size. Specimens were secured early in October.

17. **Querquedula cyanoptera** (Vieillot). Cinnamon Teal

Commonly breeding in northeastern California. Clear Lake (Finley, 1911, p. 348). Tule Lake (Bryant, 1914, p. 230). I found it at Tule Lake, May 30, 1922; at Jess Valley in June, 1923, breeding in the irrigated meadows there; and one female was seen on May 31, 1925, at the fast drying-up laguna near Eagleville, acting as if it had young ones near by. As no trace of young could be found, it seemed most probable that they had been destroyed recently by some hawk or predatory animal. This species leaves very early for the south. A pair seen at Goose Lake in the middle of June, 1925 (James Moffit, MS).

18. **Spatula clypeata** (Linnæus). Shoveller

Recorded in a general way as an abundant winter visitant to suitable localities throughout the state and as remaining locally through the summer in small numbers, but apparently the only published record for Modoc County is one from Clear Lake (Finley, 1911, p. 348), undated, but the context indicates that the birds were seen after the nesting season. Duck hunting residents state that this duck breeds in Surprise Valley and is quite abundant in wet seasons.

19. **Dafila acuta tzitzioha** (Vieillot). American Pintail

Breeds commonly in suitable places and is present through the winter season, as reported by settlers. Noted by Academy parties on various occasions in Jess and Surprise valleys, both breeding and in the fall. Very numerous on the laguna at Eagleville in the fall of 1925.

20. **Marila americana** (Eyton). Redhead

Clear Lake (Finley, 1911, p. 348). Recorded as breeding on the north shore of Tule Lake (Bryant, 1914, p. 229). The
north shore of Tule Lake extends such a short distance into southern Oregon that it is not reasonable to suppose that such species of ducks as breed on the north shore would never cross the imaginary state line—something like ten miles away—into Modoc County. One was shot by Denver, of the Academy party, near Eagleville on October 4, 1925.


Clear Lake (Finley, 1911, l. c.). A small flock of ducks of this species was noted by Jack Malloch and myself, October 9, 1924, on a small reservoir a few miles east of Alturas. Some people passing by this reservoir reported having seen there some “white-bodied ducks with dark heads.” We were fortunate in being able to approach within such short range of this flock as to make identification of its members an easy matter. Three individuals were noted by myself on October 2, 1926, on the long pond at Boyd’s Springs, barely out of gunshot range. These were swimming among a lot of Coots and were carefully examined through field glasses. A heavy duck charge was expended upon them, but they were just too far away for effect. This species is rarely seen in the county, apparently.

22. *Marila marila* (Linnaeus). Scaup Duck

Clear Lake (Finley, 1911, l. c.). Plentiful at Clear Lake in April, 1918 (Willett, 1919, p. 199). Willett states that this species and the following were positively identified by himself, but that he was unable, on account of their similarity at long range, to make any estimate of their relative numbers. Evening discussions around the stove in the general store in Eagleville developed the fact that this duck is commonly present in winters when Cameron Lake, close by, is full of water.

23. *Marila affinis* (Eyton). Lesser Scaup Duck

Noted at Clear Lake by Willett in April, 1918, with the above species. In the discussions referred to in the preceding paragraph, reliable duck hunters stated that they had noticed that there were two kinds of “bluebills” frequenting the lake
in wet winters, one smaller than the other and a little different. In all probability some of these smaller ducks were *M. affinis*, while the others may have been of the following species.

24. **Marila collaris** (Donovan). Ring-necked Duck

Three pairs were observed at close range with field glasses at the mouth of Willow Creek, Clear Lake, on April 6, 1918 (Willett, 1919, p. 199).

25. **Charitonetta albeola** (Linnaeus). Buffle-head

Female seen at Clear Lake, April 7, 1918 (Willett, 1919, p. 199).

26. **Erismatura jamaicensis** (Gmelin). Ruddy Duck

Clear Lake (Finley, 1911, l. c.). Eight individuals were noted on the north shore of Tule Lake and an egg of this species was discovered in the nest of a *Marila americana* on June 2, 1914 (Bryant, 1914, p. 230). As in the cases of the two species of Scaups above mentioned, this record seems logically applicable to Modoc County. This species of duck, however, was not known to residents of Surprise Valley. One was shot by a hunter on October 12, 1925, at the laguna near Eagleville, and brought to me for identification. Six individuals of this species were noted at Menlo Baths October 1, 1926, and one hornotine was secured, for the record.

27. **Chen hyperboreus hyperboreus** (Pallas). Snow Goose

Four birds seen at Clear Lake, April 6, 1918 (Willett, 1919, p. 199). Two individuals noted by Academy party on October 1, 1926, among a large flock of *Branta* that were sunning themselves along a small stream that still had in it enough water to reach a little way into the sandy bed of Lower Lake, about three miles southeast of Eagleville, where there was no way of approaching within gunshot of the flock. Residents of Surprise Valley say that in former years, before the soil of the valley had been impoverished by con-
tinuous cropping and over grazing, and before the series of dry years that have been recently occurring, this goose came into the valley in winter in great numbers, and did considerable damage in the grain fields. There is comparatively little grain now sown there, but the Snow Goose is still to be found in fall and winter, though in sadly reduced numbers.

28. **Anser albifrons albifrons** (Scopoli).

European White-fronted Goose


29. **Branta canadensis canadensis** (Linnaeus). Canada Goose

Breeds extensively at Clear Lake. Forty-six nests examined by Willett at the time of his visit in 1918, most of the nests containing from four to seven eggs, a few with more than that number, possibly the product of two females (Willett, 1919, p. 199). Many nearly full-grown young, with 16 adults, were seen on a pond a mile west of Davis Creek post-office, June 12, 1925 (James Moffitt, MS). Bands of geese of this genus were noted by Academy parties in the fall of 1924 and 1925, many, if not all, of which being probably of this species. Unfortunately none was secured for identification, as they were extremely wary. This species breeds to some extent at Goose Lake. Nesting at Tule Lake, June, 1918; eggs there secured by Dr. John Van Denburgh are in the Academy collection. Reported by residents to be common during migrations, with every probability of other subspecies being present at such times.

30. **Branta canadensis minima** Ridgway. Cackling Goose

This goose is commonly recognized by hunters of the county and is present in favorable winter seasons, but as yet is of undetermined status as regards numbers present and duration of visits. From Tule Lake there are nine records of banded birds secured in October, November, and December, 1924
On October 15 the first of these birds was taken definitely in Modoc County, while the other “points of capture” are well distributed around the shores of the lake. These nine geese had been banded in July, 1924, near the mouth of the Yukon River, by O. J. Murie and Herbert W. Brandt.

31. **Cygnus columbianus** (Ord). Whistling Swan

Reliable local authorities state that swans are very plentiful in Surprise Valley at times when there is water in the lakes, arriving in November and remaining until March. They do not always wait, however, for much water, as, according to Messrs. James A. and Frederick Street, great numbers were present in Surprise Valley in the winter of 1925-6, when there was so little feed, on account of drought, that a large percentage of the swans died from starvation, disease, or the effects of alkali, possibly. Mr. Frederick Street caught one swan and put it in his yard in Eagleville, where it lived for several weeks and became quite tame, but finally died. As the swan had been eating well at first, it looked very much as if its death had been caused either by disease or alkali poison.

32. **Plegadis guarauna** (Linnaeus). White-faced Glossy Ibis

Goose Lake, June 10, 1912, several individuals noted (Dawson, 1923, p. 1925). The “black curlews” reported by hunters as having occasionally been seen in Surprise Valley must belong to this species.

33. **Botaurus lentiginosus** (Montagu). Bittern

Summer visitant, of wide-spread distribution. On June 13, 1923, I watched with much interest an individual that we came upon suddenly in Jess Valley, as it “froze” into the remarkable and characteristic resemblance to a wooden stake sticking up out of the swamp grass. Had we not seen it a few seconds before it assumed this pose, we should have passed it by, a few yards distant, absolutely unnoticed. It
remained immovable for about ten minutes as we watched it, and then suddenly faded from sight as our attention was distracted by something else. One flushed at 20 yards at Menlo Baths on October 1, 1926, but I was stalking some ducks at the moment, in order to identify the species, and so did not secure the Bittern.

34. *Ardea herodias hyperonca* Oberholser.

California Great Blue Heron

About 100 great blue heron nests were noted on islands in Clear Lake in early April, 1918 (Willett, 1919, p. 200). Some of these nests contained full complements of eggs by April 6. Reported by reliable residents of Surprise Valley to be seen there at times, but not noted by Academy parties. Two herons were secured by Academy parties on the Pit River, between the Pit River Forest Service Station and Canby in September, 1926. They are both birds-of-the-year and are too dark to be within the limits of *treganzai*. Logically *hyperonca* should be the subspecies found in this part of the county, as it would be perfectly natural for the heron, in its search for food, to work its way up the Pit River, which is a tributary of the Sacramento River along which it is commonly found. It does not follow, however, that another subspecies may not be found in the lake region of the north-western part of the county which is separated from the Pit River Valley by quite a stretch of unwatered desert country.

35. *Chasmerodius egretta* (Gmelin). Egret

Summer visitant, formerly in numbers (Henshaw, 1879, p. 2301), but now apparently very rare. “A few” were reported as breeding at Clear Lake in 1911 (Finley, 1911, l. c.).

36. *Nycticorax nycticorax nævius* (Boddaert).

Black-crowned Night Heron

Summer visitant. Specimens from Modoc County in the Museum of Vertebrate Zoology. A pair noted at Clear Lake, April 10, 1918 (Willett, 1919, p. 200). Noted by the Acad-
emy party at Willow Ranch, Goose Lake, where it was nesting in May, 1923, and one specimen was taken near the Pit River Ranger Station, August 29, 1926.

37. *Grus canadensis* (Linnaeus). Little Brown Crane

Spring and fall migrant. Possibly a few winter in the county. In 1924 the Academy party arrived in Eagleville on September 5, and two days later cranes were noted flying in small bands over the nearby meadows, but probably some were already there at the time of our arrival. Other bands came in and some of them remained to feed on the grain in the stubble fields, evidently preferring wheat to the other grains.

These birds are very wary and seldom alight to feed in the vicinity of cover large enough to allow the unseen approach of a human enemy or of even a well-meaning observer. However, before the end of September frequent attempts to approach feeding bands had given me enough experience to make me believe that it was possible to distinguish the *canadensis* from *mexicana*. Old residents accustomed to duck and goose shooting in Surprise Valley call the *Grus canadensis* the "Little Blue Crane" or the "Turkey-foot", and claim that it always maintains a certain aloofness from *G. mexicana*. My own observations seem to confirm this hypothesis, as far as it is possible to judge of size through field glasses. In fact, it was my having observed bands of what appeared to be smaller cranes feeding in the stubble fields not joining or mixing with other bands near at hand, apparently composed of larger individuals, that led me to discuss the matter with resident hunters. These hunters claimed that they could readily recognize the two species by the differences in habits as well as the difference in size. The hunters had often been on horseback among the cranes, which sometimes allow a horseman to come relatively near them, and were in a better position to judge of this matter than was I. The birds vary a good deal at different times, often being just about as difficult to approach on horseback as on foot. On several occasions ranchmen unwittingly put to flight flocks of cranes when we had managed to crawl up almost within shooting range.
On October 7, 1924, a female bird-of-the-year was secured. It weighed six pounds nine ounces (2.98 kilograms).

There were more cranes in the Surprise Valley meadows in the fall of 1925 than there were the previous year, and much more stubble for them to feed upon, but fortune did not favor us and only one bird of this species was secured. This proved to be an adult male, which weighed nine pounds one ounce (4.1 kilograms).

38. _Grus mexicana_ (Müller). Sandhill Crane

Summer visitant, possibly remaining late in the fall, but so many migrants come in to the county in the end of August or beginning of September that there is no way of knowing whether the breeders linger late, or depart early and are replaced by others from farther north. Henshaw (1897, p. 2301) states that "these large birds are so numerous in so many portions of Nevada, California, and Oregon that it is scarcely worth while to particularize localities." This state of affairs is now sadly changed by the encroachment of human beings upon the natural breeding grounds, the reclamation of marsh lands, etc. However, the cranes yet nest to some extent in the county. A nest containing pieces of eggshell was found by myself at the laguna near Eagleville on May 27, 1924, and two young birds from different nests were noted (Mailiard, 1924, p. 216).

This crane migrates in considerable numbers through Surprise Valley in the fall, pausing for some weeks to feed on the scattered grain in the stubble fields, and the general remarks upon _Grus canadensis_ apply equally well to this species. Its numbers in the fall of 1924 were less than customary, according to the statements of residents, presumably on account of the then prevailing drought. On September 17, a female bird-of-the-year was secured, the weight of which was nine pounds 14 ounces (4.49 kilograms), and on October 1, 1924, an adult male was taken, weighing 11 pounds 13 ounces (5.31 kilograms).

In 1925 and 1926 a much larger representation was in evidence. On the morning of September 7, 1926, Gilmore (a member of the Academy party), with a 22-caliber rifle,
wounded a male bird-of-the-year which flew off about 200 yards and tried to hide in some weeds. When the flock arose, another crane, which afterwards proved to be an adult female, accompanied the wounded one and stayed by it while Gilmore approached and secured both of them at short range. This conduct seems to indicate that the female parent crane remains attached to its young for a considerable period after the nesting season.

39. Porzana carolina (Linnaeus). Sora

There does not seem to be any published record for this rail in Modoc County. Henshaw (1879, p. 2302) gives it as being common throughout the summer, although not so numerous as Rallus virginianus, but gives no definite locality. However, we have in the Academy collection a set of eggs of this bird, from near Alturas. This set was taken by Dr. Barton Warren Evermann, director of the Museum, on June 9, 1918, while he was on a collecting trip with the late Dr. John Van Denburgh and Mr. Joseph R. Slevin, curator and assistant curator, respectively, of the Department of Herpetology. In his notes of this trip Doctor Evermann mentions this species as having been seen on other dates as well. It is given by other authorities as being common throughout the state in summer time, but again no definite reference to north-eastern California.

40. Fulica americana Gmelin. Coot

Breeding commonly in suitable places throughout the county. Possibly resident to a greater or less extent.

41. Lobipes lobatus (Linnaeus). Northern Phalarope

Probably a straggler or casual migrant. Noted at Goose Lake, June 24, 1912, and Surprise Valley, July 12, 1915 (Dawson, 1916, p. 25). On October 3, 1926, three individuals were secured by the Academy party at the southern end of Surprise Valley just inside the southern line of Modoc County.
42. **Steganopus tricolor** Vieillot. Wilson’s Phalarope

Summer visitant to suitable places in northeastern section of the state (Grinnell, 1915, p. 48). Breeds sparingly at Goose Lake (Dawson, 1923, p. 1184). Noted by the Academy party in May and early June, 1924, at the laguna near Eagleville, where drought conditions prevented it from nesting. Several pairs of these phalaropes stayed for some time in the vicinity of the laguna and were even seen feeding by the roadside in a shallow ditch that held an inch or two of water from a spring near by. By the middle of June they disappeared, as about all the water in the vicinity had dried up.

43. **Recurvirostra americana** Gmelin. Avocet

“Common summer visitant to the Modoc (plateau) region . . .” (Grinnell, Bryant and Storer, 1918, p. 339). Noted by the Academy party in May and June, 1924, at the southern end of Surprise Valley, where there yet were some swampy places and meadows irrigated in spite of prevailing drought conditions. From their actions these birds must have been nesting, but no attempt was made to find their nests, as the country was large and the birds few. The only fall occurrence noted was on October 2, 1926, when five individuals of this species flew over my head at the ponds of Boyd’s Springs and settled down in shallow water in the middle of the smaller pond. According to residents of Surprise Valley, this species used to nest in large numbers in favorable seasons.

44. **Himantopus mexicanus** (Müller). Black-necked Stilt

“Common summer visitant to interior localities . . . chiefly east of the Sierras at the north, . . . .” (Grinnell, 1915, p. 49). Henshaw (1879, pp. 2296, 2297) remarks upon the presence of this species and the foregoing in *all* of the territory covered by the field parties west of the Rocky Mountains, except in the highest mountain districts. “Common summer resident in the Modoc district” (Dawson, 1923,
p. 1204). Apparently Stilts were very numerous in the days before the lakes went dry, and they nested in Surprise Valley on the same ground as did the Avocets, the nests intermingled indiscriminately. In the recent droughts the nesting grounds have been greatly restricted and are probably confined to the vicinity of the large lakes that never go dry.

45. **Gallinago delicata** (Ord). Wilson's Snipe

Migrant through the state and commonly breeding in the meadows of Modoc County. Frequently noted by Academy parties in nesting seasons of 1923 and 1924, when many individuals were seen perched on top of fence posts along the roads, and heard, particularly at night, going through their aerial courting performances.

46. **Pisobia minutilla** (Vieillot). Least Sandpiper

Two were noted at Clear Lake, April 10, 1918 (Willett, 1919, p. 202).

47. **Limosa fedoa** (Linnaeus). Marbled Godwit

A female was shot on the laguna near Eagleville on October 11, 1925, by William Barnes, a local hunter, to whom and to other sportsmen of Surprise Valley it was an unknown species. The specimen was presented to me and is now in the Academy collection. It probably is the first specimen on record as taken in California east of the Sierras.

48. **Totanus melanoleucus** (Gmelin). Greater Yellow-legs

This species is a migrant over the state generally, but probably is very sparingly so in the northeastern part. Dawson (1916, p. 25) gives a record for Eagleville, June 30, 1912.
49. *Catoptrophorus semipalmatus inornatus* (Brewster).  
Western Willet

Common migrant in spring and fall. Breeds to some extent in the county. Vicinity of Goose Lake (Mus. Vert. Zool.). Nesting in Surprise Valley in May and June, 1924 (Mailliard, 1924, p. 216), judging from the actions of the birds when we were in the meadows, both at the southern end of Middle Lake and at the southern end of the valley.

50. *Actitis macularia* (Linnaeus). Spotted Sandpiper

This sandpiper is known to breed in the lake region of northeastern California (Grinnell, Bryant and Storer, 1918, p. 432). The only time we noted the species in Modoc County was on May 27, 1923, when I found one or two individuals on the shore of Cave Lake, at an altitude of about 7000 feet. During the few hours passed there, it snowed a good part of the time, and some people fishing around the little lake disturbed the birds. I saw a Spotted Sandpiper flitting along the shore, often alighting close to me, but whether there was only one present, or more, I could not find out. Davis Creek, near Goose Lake, noted, June 12 (James Moffitt, MS).

51. *Numenius americanus* Bechstein. Long-billed Curlew

Common spring and fall migrant. Breeds in suitable places. Noted at Goose Lake in June, 1910 (W. P. Taylor, MS). We found it nesting in Surprise Valley in May and June, 1924, both near Eagleville and at the south end of the valley. The young were hatched by the time we came across this species. A ditch tender reported that between May 20 and 25, he had found a nest with four eggs, but by the time he showed us the nest, June 9, the young had hatched out and left.

52. *Oxyechus vociferus vociferus* (Linnaeus). Killdeer

Summer visitant. Common in all favorable localities. A few remain through open winters, according to reports.

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53. **Charadrius nivosus** (Cassin). Snowy Plover

The only record that I know of for the county reads, "Of regular occurrence at Goose Lake and manifestly breeding (or trying to do so; . . . .)," in June, 1912 (Dawson, 1916, p. 26).

54. **Oreortyx picta plumifera** (Gould). Plumed Quail

Common resident in many parts of the county in suitable association, but rapidly becoming scarcer. At Deep Creek the Academy party noted quite a number in 1923, but in September, 1924, Ranger Ben Johnson stated that in that summer there was only one small band in the cañon, this band consisting of a pair of adults and 12 young ones. This covey, he said, frequently came into the station yard to eat food put out for them, but an overnight visit to the station and a trip some distance up the cañon failed to reveal to us the presence of any of these birds. The Buck Creek Ranger Station was visited by Academy parties both in 1923 and 1924. In the former year there were quite a few of these quail about the station in the spring, but in June, 1924, one juvenile, accidentally caught in a mouse trap, was the only one seen and none was heard calling. Ranger Lawrence Smith told me that quite a number come down from the higher ranges in the fall to the level of the station (5000 feet).

On the other hand, this bird was fairly numerous in the fall of 1926, at least in Surprise Valley, after a temperate winter and spring most favorable for nesting and raising young. There was even a flock of these quail living and feeding in the kitchen gardens of Eagleville. Some residents believed that the severe drought and consequent scarcity of water on the Nevada side of the valley, just east of which is an extensive game refuge in the sage-covered mountains, had driven many of the game birds over the state line and to the west and better watered side of the valley.

55. **Lophortyx californica vallicola** (Ridgway). Valley Quail

Common resident and much more numerous than the preceding species. On the Warner Mountains it ranges up to
6000 feet and over. The nesting season in this region seems to be prolonged late into the fall, for so late as the first week in October, 1925 and 1926, I noted several broods of very young birds, some of which could not have been over two weeks old.

For the same reason as given in the case of the preceding species, this quail was very abundant in 1926, so much so in places as seriously to interfere with the banding of sparrows that was being carried on. This species of quail was introduced into Surprise Valley some few years ago, presumably from the west side of the Warner Mountains, by an enthusiastic sportsman, and have increased to a remarkable extent when it is considered that in severe winters a very large percentage of both this species and the preceding is destroyed through inability to procure food when the ground is covered by deep or frozen snow.

56. **Dendragapus obscurus sierrae** Chapman. Sierra Grouse

Resident at considerable elevation in the coniferous forests along the Warner Mountains. The notes of the 1910 field party from the Museum of Vertebrate Zoology show that this bird was scarce even at that time, as but few were encountered. Old residents of the county state that it is rapidly becoming scarcer. The destructiveness of man in addition to its natural enemies evidently is making too strong a combination to permit it to maintain itself. The Western Goshawk (*Astur atricapillus striatulus*) seems to be one of the most destructive of its enemies. This hawk is comparatively numerous in the mountains and is reported to be exceedingly clever in its method of attack upon the grouse.

57. **Pedioecetes phasianellus columbianus** (Ord).

Columbian Sharp-tailed Grouse

Henshaw (1879, p. 2295) says, "About Camp Bidwell, Cal., the 'sharptails' are sufficiently numerous to afford excellent shooting, and good bags may be made there." At present this species is here practically or actually extinct. During
our stay in Eagleville, in 1924, there were some rumors to the effect that one or two small bands had been seen in Modoc County within the previous two or three years, but nothing authentic was learned in regard to this.

58. *Centrocercus urophasianus* (Bonaparte). Sage Hen

This species was also at one time a very abundant resident of Modoc County, but now its numbers are sadly depleted, although reported by residents to have been fairly numerous up to a recent date. In the dry year of 1924, it seemed to be especially scarce, as repeated efforts on our part failed to reveal more than two or three very small bands within ten or 12 miles of Eagleville, in the particular habitat of this grouse. In 1925 there appeared to be more of them on the ranges, as, for instance, a band of about 300 birds was reported to me as having been flushed in a place where only a small flock had been found the year before. These birds were reported to be more numerous in 1926, because of favorable weather conditions during the preceding winter and spring. On the very edge of Eagleville a small flock of Sage Hens had located in the meadow land in the late summer. This seemed to be a strange sort of habitat for this genus, but the band probably had wandered over from the sage brush on the parched Nevada side of the valley. Much of the increase noted above may have been due to an invasion of this sort.

59. *Zenaidura macroura marginella* (Woodhouse). Western Mourning Dove

Common resident over the plateau region of northeastern California. Noted by the Academy parties in about every place visited except the forests of the higher mountain ranges.

60. *Cathartes aura septentrionalis* Wied. Turkey Vulture

Common except in late fall and winter, but apparently not very abundant. Earliest seasonal date noted by Academy parties was May 9, and the latest about September 20.
61. *Circus hudsonius* (Linnaeus). Marsh Hawk

Commonly found in summer over all of the meadow lands and marshes. In September, 1924, the season of great drought, it was frequently seen hunting over large sagebrush areas. One individual was taken by the Academy party on June 9, 1924, at an elevation of about 6000 feet, on top of a chaparral ridge, near Happy Camp Forest Service Station, where apparently it was hunting for sparrows or other small birds.


Winter visitant, with possibly a few resident in the mountains below the Boreal zone. Occasionally noted in Surprise Valley by the Academy party in the fall of 1924 and 1925.

63. *Accipiter cooperi* (Bonaparte). Cooper's Hawk

Found by the Museum of Vertebrate Zoology field party to be breeding at a considerable elevation on Parker Creek in 1910, the record being supported by specimens secured. Apparently not numerous in the county, as this hawk was not at any time identified by Academy field parties.

64. *Astur atricapillus striatulus* Ridgway. Western Goshawk

Breeds in the Boreal zone on the Warner Mountains (Mus. Vert. Zool.). Possibly some pass the winter at lower levels in the county. Several individuals were seen and specimens secured by the Academy party near Eagleville in September, 1924, they apparently having come down from the mountains. An adult female was taken on September 22, on the mountain side in Emerson Cañon, while devouring a Sierra Grouse that it had caught, and of which there was but little left at the time the hawk was shot.

65. *Buteo borealis calurus* Cassin. Western Red-tail

Common resident in Upper Sonoran and Transition zones, rather numerous in places.
66. *Buteo swainsoni* Bonaparte. Swainson's Hawk

Henshaw (1879, p. 2292) speaks of this hawk being abundant in summer in northern California, and, to judge from the context of the report, Modoc County must have been included in this territory, as much work was done there. Goose Lake, June, 1912, apparently nesting; also birds seen near crest of Sugar Hill (Dawson, 1916, p. 26). Noted southeast of Tule Lake on May 18, 1918 (Grinnell, MS). This hawk was not noted by Academy parties until the fall of 1926, when one was shot four miles west of Alturas on September 1, another was secured at Eagleville on September 4, and several more were seen in the next few days, but none appeared after September 12.

67. *Archibuteo ferrugineus* (Lichtenstein).

Ferruginous Rough-leg

"A hawk was seen in northeastern California which I believe to be of this species" (Henshaw, 1879, p. 2293). Sight records by Academy field parties at the head of Deep Creek Cañon and in Jess Valley, May and June, 1923 (Mailliard, 1924, pp. 213-4). On September 18, 1924, in a stubble field just east of Eagleville, two adult birds of this species, in very light phase, soared over my head just out of gunshot range, circling higher and higher after they noticed my presence. I had the same experience with what seemed to be the same two hawks in the same field one day in September, 1925. At other times this species had been noted in Surprise Valley under conditions not quite so satisfactory for identification as in the two cases just mentioned, but sufficiently so as to leave no doubt in my mind as to the species.

In the fall of 1926, with two assistants, I made even more especial efforts to procure a specimen. Several individuals were seen at different times, but the constant persecution of all large hawks by farmers and boys made approach in most cases out of the question. However, after several encounters that should have been successful, but were not, a fine male fell before my rifle on October 2, seven miles north of Eagleville. This seemed to break the spell, for my assistants
secured another male in Surprise Valley on October 6, and we picked up yet another on the highway on October 7, about a mile west of Pittville, just at the eastern edge of Shasta County. This bird evidently had been shot by some passer-by a day or two before and left lying in the hot sun, but a leg and foot was taken as a record for that county.

68. *Aquila chrysaetos* (Linnaeus). Golden Eagle

Common resident in suitable localities, but not numerous. Noted by the Academy party at Pit River Forest Service Station on June 1, 1923, and at Eagleville on September 6 and 18, 1924. On this latter occasion one of these eagles circled over my head at close range so soon after the Ferruginous Rough-legs had done so that all three of the birds were circling around at the same moment. On September 17, 1925, we passed an immature bird that was sitting on a fence not 50 yards from our car. In 1926 several individuals were noted at various times. On October 2, three were in sight at once between Lake City and Boyd's Springs.

69. *Haliaeetus leucocephalus leucocephalus* (Linnaeus). Bald Eagle

Two individuals were seen at Clear Lake, April 8, 1918 (Willett, 1919, p. 203).

70. *Falco mexicanus* Schlegel. Prairie Falcon

Common near Camp Bidwell (Henshaw, 1879, p. 2292). Judging from the number of times this falcon was noted by Academy parties, it must be a common resident in the Transition zone on the eastern side, at least, of the Warner Mountain range. In May and June, 1924, one was occasionally seen looking for food in the meadow land of Surprise Valley, always giving the impression that it had come from the foothills of the range. One was obtained near Eagleville on September 22, 1924, and to quote from my field notes of the following day, I saw "two Prairie Falcons together right over Main Street in town [Eagleville] this morning, flying
low. Good many about." It was also noted on different occasions in the fall of 1925, but there were not so many as in the previous year. Often noted in Surprise Valley in the fall of 1926. Seen often in the Warner Mountains and on Warren Peak in June and July, 1912 (Dawson, 1916, p. 26).

71. *Falco columbarius columbarius* Linnaeus. Pigeon Hawk

On September 6, 1924, I saw a falcon that I took to be of this species, just out of gunshot range at the southern end of Surprise Valley. A female was shot by a schoolboy of Eagleville, September 24, 1925, and brought to me to add to our collection. Another one was noted near Eagleville in late September, 1926.

72. *Cerchneis sparveria sparveria* (Linnaeus).

American Sparrow Hawk

Common over most parts of the county, at least from early spring until late fall. Probably some remain through ordinary winters in the more favorable localities. Several specimens were secured.

73. *Pandion haliaëtus carolinensis* (Gmelin). Osprey

"Present on nearly all the streams and lakes that furnish fish" (Henshaw, 1897, p. 2293). Goose Lake, June 17, 1912, one bird seen (Dawson, 1916, p. 26). "Pairs of birds seen daily at Clear Lake" (Willet, 1919, p. 204). Found by the Academy party to be nesting on the South Fork of the Pit River in June, 1923, near the Pit River Forest Service Station. The nest was in the top of a tall pine on a hillside on the south side of the river some distance away, but the birds could be recognized from the station even without the aid of field glasses. Ospreys were seen in the same locality in August, 1926, during our stay at the forest service station.
74. Tyto alba pratincola (Bonaparte). American Barn Owl

Resident. Rather common at Fort Bidwell (Henshaw, 1879, p. 2291). None were met with, as it happens, by Academy parties, but this owl was reported by residents to be found often in the tangled willow thickets along streams in the meadow lands of Surprise Valley. An adult was secured near Eagleville by Mr. James A. Street, and sent in the flesh to the Adacemy, November 18, 1926.

75. Asio wilsonianus (Lesson). Long-eared Owl

Noted at Goose Lake, two immature birds secured June 5, 1910 (Mus. Vert. Zool.). This owl was seen several times in Surprise Valley in the fall of 1926. Two were secured near Eagleville, and on September 30, I flushed a family group in a small rocky gully in the sagebrush desert on the eastern side of Middle Lake and secured two of the immature birds.

76. Bubo virginianus occidentalis Stone. Pale Horned Owl

Resident. There are two young birds in the Museum of Vertebrate Zoology that are doubtless of this subspecies, though they were originally catalogued as pacificus, one taken at the head of Pine Creek, Warner Mountains, and the other at the Scott ranch, ten miles north of Alturas, in July, 1910 (Swarth, 1921, p. 136). In the collection of the California Academy of Sciences there is an adult male from the Warner Mountains, taken by John Rowley, September 24, 1913, and another male that was brought to me from two miles north of town by an Eagleville schoolboy on October 7, 1925. Both of these specimens I have confidently placed in the category of occidentalis, not as typical of this race, but as being decidedly nearer to it than to pacificus. Inhabitants of Surprise Valley stated that horned owls come down from the mountains in the fall and return to the higher timber early in the spring for the nesting season, after having passed the winter in the lowlands of the county. Most probably this is the owl recorded, erroneously under the name of pallescens,
as nesting at Clear Lake, with two nearly incubated eggs in the nest on April 7, 1918 (Willett, 1919, p. 204). In 1926 this owl also was more numerous in Surprise Valley than had previously been my experience. Two were secured, one of them taken in the town of Eagleville, and several others were noted by our party.

77. Speotyto cunicularia hypogæa (Bonaparte).
Burrowing Owl

Resident, but not numerous (Mus. Vert. Zool.). Two noted in Surprise Valley "back of Dyke's barn," which must have been near the mouth of Granger (Dry) Creek cañon. Present in Surprise Valley in the fall of 1924 and 1925, but scarce. One specimen was secured in September, 1926, near Eagleville.

78. Glaucidium gnomae, subspecies

On September 20, 1922, "the typical notes of a pigmy owl" were heard at dawn at Steele Meadow (Grinnell, MS). Doctor Grinnell is too well versed in bird notes to allow of much doubt as to the species of the originator of those notes. Soon after daylight on the morning of August 31, while we were in camp at the Pit River Forest Station, a pygmy owl commenced to call on the partly wooded hillside above us. The attention of the rest of our party was called to this fact, but we failed to locate the tree from whence came the sound before it ceased and was not resumed. Search for the bird was unsuccessful.

79. Ceryle alcyon caurina Grinnell.
Northwestern Belted Kingfisher

Noted at Davis Creek, Dry (Granger) Creek, Parker and Payne creeks, in June, July, and August, 1910 (H. C. Bryant and W. P. Taylor, MSS). Several seen at Steele Meadow, September 30, 1922 (Grinnell, MS). Individuals were noted in the fall of 1926, fishing along the Pit River, below Canby.
80. **Dryobates villosus orius** Oberholser. Modoc Woodpecker

Resident in suitable places throughout the county. Noted by Academy parties at every place visited.

81. **Dryobates pubescens homorus** Cabanis & Heine.

Batchelder’s Woodpecker

Warner Mountains (Mus. Vert. Zool.). Recorded as a summer visitant to these mountains (Grinnell, 1915, p. 77). Apparently it is not numerous anywhere. At the end of May, 1924, a pair was nesting in a tall cottonwood across the road from our quarters just north of the town of Eagleville. Only two specimens were secured by Academy parties in the spring, but several were taken near Eagleville in the fall, when there appeared to be a slight vertical migration to the floor of the valley.

82. **Xenopicus albolarvatus albolarvatus** (Cassin).

White-headed Woodpecker

Resident on the Warner Mountains (Grinnell, 1915, p. 79). We did not come across this species at the lower levels visited, say, at 4500 to 5000 feet, but it probably is to be found there in some of the pine forests of the county, as this seems to be a favorite altitude for it elsewhere.

83. **Picoides arcticus** (Swainson).

Arctic Three-toed Woodpecker

Resident on the Warner Mountains (Grinnell, 1915, p. 79). One male was taken by the Academy party at Red’s Camp, 12 miles southwest of Eagleville on September 16, 1926.

84. **Sphyrapicus varius nuchalis** Baird. Red-naped Sapsucker

Very common in suitable localities in Transition and Canadian zones. Nesting in many of the places visited by the Academy parties. One nest examined by myself, in a willow
tree on the bank of a small stream in Jess Valley contained young three or four days old on June 14, 1923. Numerous in Eagleville during September and early October, at least in 1924 and 1925. It was noticeable that a rapid increase in numbers took place after heavy snow covered the higher altitudes of the Warner Mountains. While commonly met with in September and October, 1926, this species was present in much smaller numbers than we had previously found it. This might be accounted for by the insignificant snowfalls and the few storms of this fall.

85. **Sphyrapicus varius daggetti** Grinnell.
   Sierra Red-breasted Sapsucker
   Resident in small numbers on the Warner Mountains (Grinnell, 1915, p. 80).

86. **Sphyrapicus thyroideus** (Cassin).
   Williamson's Sapsucker
   Common in summer at the higher altitudes of the Warner Mountains (Grinnell, 1915, p. 80). Taken at 7500 feet elevation near Eagle Peak by both F. Tose and myself, in June, 1924.

87. **Asyndesmus lewisi** Riley. Lewis's Woodpecker
   Resident. Commonly breeding in all suitable localities and scattering in the fall according to food conditions.

88. **Colaptes cafer collaris** Vigors. Red-shafted Flicker
   Resident in all suitable places in the county.

89. **Phaenoptilus nuttalli nuttalli** (Audubon). Poor-will
   Common summer visitant to Upper Sonoran and Transition zones. Warner Mountains (Grinnell, 1915, p. 83). Noted by myself in the Deep Creek cañon, near Cedarville, May 9-15, 1923, and specimens taken. Also at Eagleville in May, 1924.
I secured an adult male a few miles east of Eagleville in a rocky part of the desert, September 18, 1925, and another was taken near Eagleville, September 6, 1926.

90. *Chordeiles virginianus hesperis* Grinnell.  
Pacific Nighthawk

Common summer visitant to a large area in Modoc County. Parker Creek, Sugar Mountain, Squaw Mountain, June and July, 1910 (H. C. Bryant and W. P. Taylor, MSS). Taylor (MS) reports that, at the time he was on the 1910 field work in Modoc County, he heard the notes of this bird at night as early as May 26, but the first sight record seems to be by Bryant (MS) on June 8. During several years' experience in field work at moderately high altitudes in northern California, the earliest date on which I have heard this night-hawk has been June 2. It was seen frequently at Eagleville in the latter half of September in 1924, 1925, and 1926, on the southward migrations.

91. *Archilochus alexandri* (Bourcier & Mulsant).  
Black-chinned Hummingbird


92. *Selasphorus rufus* (Gmelin). Rufous Hummingbird

Noted at Warren Peak, July 16 to August 9, 1910 (W. P. Taylor, MS, and specimens in Mus. Vert. Zool.). Noted by myself in Surprise Valley in September, 1924, and one specimen secured on September 13. There were quite a few around the wild rose bushes among the willows about two miles north of Eagleville, but they were practically impossible to retrieve in the dense growth, so that but one was taken. A female bird-of-the-year was taken at the Pit River Forest Service Station on August 31, 1926.
93. **Stellula calliope** (Gould). Calliope Hummingbird
Common summer visitant in all suitable places.

94. **Tyrannus tyrannus** (Linnaeus). Kingbird
Rare summer visitant. Sight records at Pit River about eight miles above Alturas, June 15; Surprise Valley, near Eagleville, June 30, 1912 (Dawson, 1916, p. 27). An immature female was taken in the vicinity by myself on September 4, 1926. This was quite a young bird.

95. **Tyrannus verticalis** Say. Arkansas Kingbird
Common in Upper Sonoran and Transition zones in spring and early summer in all favorable localities. Noted by the Academy party as early as May 9, but it may have arrived even earlier. On several occasions it was observed to be nesting in pine trees, rather than in smaller trees of other varieties. A few remain until early September. A male adult was taken near Eagleville on September 7, 1926, and other individuals were noted during the next few days.

96. **Myiarchus cinerascens cinerascens** (Lawrence). Ash-throated Flycatcher
An immature male of this species was taken by one of our party on September 3, 1926, at Eagleville. This seems to be the most northern record for California east of the Sierras.

97. **Sayornis sayus** (Bonaparte). Say’s Phœbe
Breeds in the northeastern plateau region of California (Dawson, 1923, p. 874). Quite common in Surprise Valley in September, when specimens were secured by Academy parties.

98. **Nuttallornis borealis** (Swainson). Olive-sided Flycatcher

Western Wood Pewee

Summer visitant in all suitable places, even very high on the ranges. Earliest date noted by the Academy party was May 15 (1923) at Cedarville. Common in the fall, 1924-1925, from the middle of September well into October. Flycatchers were notably scarce in the fall of 1926, and none of this or of the following species was secured at that time.

100. *Empidonax difficilis difficilis* Baird. Western Flycatcher


102. *Empidonax hammondii* (Xantus).

Hammond’s Flycatcher

A male bird of this species was secured by myself at Cedarville on May 15, 1923, but none was positively identified at any other time or in any other place by Academy parties, and no other record found for Modoc County. However, it is so very difficult in the field to distinguish this species from the following, that one may easily overlook its presence among others of the small flycatchers. In fact, sight identifications alone of this species and the following, in places where both may occur, are practically valueless.

103. *Empidonax wrighti* Baird. Wright’s Flycatcher

Summer visitant, widely distributed in the fall, but nesting mostly confined to the mountain ranges, as in the Warner Mountains (Mus. Vert. Zool.). The only time it was noted
in spring by an Academy party was June 18, 1924, when I took two at Happy Camp at about 5000 feet altitude. These were a male and female, but there was no indication of their being paired at the time. A few individuals, presumably of this group of small flycatchers were noted near Eagleville in the latter part of September, 1925. One specimen was secured on September 17, and another on the 18th, both being female birds-of-the-year. The few noted were quite wild.

104. **Empidonax griseus** Brewster. Gray Flycatcher

Summer visitant, but not abundant. South Fork of Pit River, near Alturas, June 9, 1910 (Mus. Vert. Zool., two specimens). From among the small flycatchers just mentioned above, I took a male of this species on September 18, 1925, at Eagleville.

105. **Otocoris alpestris merrilli** Dwight. Dusky Horned Lark

Common resident in suitable places (Grinnell, 1915, p. 95). The horned larks are early breeders, and we did not arrive in Modoc County until too late to find them nesting. In fact, but few were seen in the spring. On the east side of Surprise Valley, on June 11, 1924, I obtained a young bird, well able to fly, after chasing the family for a long way over a rocky part of the desert. They were exceedingly wild. In September, 1924 and 1925, small bands were often seen by Academy parties. They gathered around water holes to drink, principally in the desert region, where specimens were secured. The bands were more numerous and of larger size in 1924, when water was so scarce, than in the following year of greater rainfall, when the birds were more scattered in their flights. On several occasions small flocks were noted on the east side of the Warner Mountain range at about the limit of Upper Sonoran, say, 6000 feet, apparently in migration. The two adults taken in spring are appreciably paler than most of our specimens of similar date from Siskiyou County (California). No horned larks were noted in Surprise Valley in the fall of 1926.
106. **Pica pica hudsonia** (Sabine). Magpie

Common resident in suitable places over much of the county. Some of the nests noted by the Academy party were so low in willow groves that they could almost be reached from the ground. Nests with eggs and others with fledglings ready to fly were noted at Goose Lake at the end of May, 1923. Quite numerous in Surprise Valley. Many family groups were observed with much interest as the young acquired their juvenile plumage. We found that it did not take long for the young to learn to keep out of range of human beings who came near them.

There was a great increase in the jack rabbit population of Surprise Valley in 1926, probably due to scarcity of food on the Nevada side, and a consequent greater number of casualties among these animals, particularly from collision with automobiles traveling at night. Magpies appeared to have gathered to enjoy the resulting feast, and were especially numerous along the highways. One was found in one of the Potter traps used in banding operations. With it were two sparrows at the other end of the trap, one of them alive and the other headless, its head being inside the magpie.

107. **Cyanocitta stelleri frontalis** (Ridgway). Blue-fronted Jay

Common resident of Modoc County wherever there are trees enough to make good cover. Quite widely distributed in the breeding season, but gathering in the fall where food is found to be most abundant. In September, 1924, this jay was so numerous in Eagleville as to be a pest in the many small apple orchards of the settlement. These orchards are small, for home supply only, and the inroads made by the jays upon the apple crop assumed serious proportions. With the crop limited as it was by the drought of that year, the owners of such orchards as were bearing fruit waged incessant warfare upon the jays, both of this species and of the following one. Hundreds were shot, but those that were left soon became expert in dodging their pursuers and the slaughter lessened. It was a surprise to find so many quite

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immature birds among those shot in late September. That some migration takes place is certain. Mr. James Street reported to me that, while deer hunting high up on the Warner range, on September 28, 1924, he had seen a flock of 50 to 60 Blue-fronted Jays flying south along the mountain side. In the fall of 1925 there was so much food in the mountains that but few of these birds came down to the apple orchards in the valleys. For some unknown reason they were not at all numerous in the orchards in the fall of 1926, in spite of the fact that the following species was abundant.

108. **Aphelocoma californica immanis** Grinnell.

**Long-tailed Jay**

Common resident in many places, but strangely absent in other parts that seem well adapted to its existence. Very numerous in Surprise Valley in the fall of 1924, when it was as fond of apples as was the Blue-fronted Jay. Not found at high altitudes. On the morning of October 1, 1924, I saw about 25 Long-tailed Jays, in a scraggily band apparently in migration, working their way south through the cottonwoods along Eagle Creek, just back of Eagleville. This jay was not particularly noticeable in Surprise Valley in the fall of 1925, but the following year, which again was one of deficient rainfall, it was about as numerous as in 1924 and was very destructive to the apple crop.

109. **Perisoreus obscurus griseus** Ridgway. **Gray Jay**

Resident locally on mountains. Young in juvenile plumage taken near Camp Bidwell (Henshaw, 1879, p. 2286). Warner Mountains (Mus. Vert. Zool.). Several specimens were taken by the Academy party in the fall of 1926.

110. **Corvus corax sinuatus** Wagler. **Raven**

On September 14, 1926, four birds, which I at first thought were vultures, were noted in the northern distance soaring rather low. As I was occupied among the sagebrush, band-
ing sparrows, these birds approached until they were directly overhead, when I discovered that they were Ravens. They kept close together and with widespread tails soared in circles, probably looking for dead jack rabbits toward the south. On our way to Boyd's Springs, October 2, 1926, a Raven was seen on a fence post in the sagebrush east of Lake City, but it took flight before we were close enough for a shot.

111. *Corvus brachyrhynchos hesperis* Ridgway.
Western Crow.

Resident to some extent. Numerous at Sugar Hill, June 30, 1910 (W. P. Taylor, MS). Davis Creek, June 10; Eagleville, June 30, 1912 (Dawson, 1923, p. 16). Noted by the Academy party at Willow Creek Ranch, Goose Lake, in May, 1923, and in Surprise Valley in May and June, 1924, breeding freely in both places. In Surprise Valley flocks gathered in the stubble fields toward the end of September, 1924. At Eagleville the local band was joined by others, the maximum being reached about September 23, when some 500 individuals stayed all day about a freshly threshed straw stack. Quite a number remained for a few days in the vicinity, but on October 3 I noticed that the flock was greatly thinned out. In September, 1925, the crows gathered as they had in the previous year. The number seemed to reach the maximum about September 23, when I estimated the size of the band to be in the neighborhood of 1000 individuals, all feeding in the stubble field back of our quarters. Ten days after this, small numbers were noted moving toward the south, which movement continued daily until comparatively few remained on October 15, when our party left the field. In the fall of 1926 crows were not nearly so numerous in Surprise Valley as in the two previous years, probably because of diminished area of grain stubble. Quite a number appeared, but they did not band much together and seemed to be moving south in small, straggling flocks. It is reported that but few remain through the winter.
112. *Nucifraga columbiana* (Wilson). Clarke’s Nutcracker


113. *Cynocephalus cyanoccephalus* (Wied). Piñon Jay

Noted May 10, 1918, southeast of Tule Lake (Grinnell, MS). On September 22, 1925, while busy at our quarters at Eagleville, my attention was attracted by the note of this bird, and I found that two individuals had just alighted on the ridge of a nearby barn. I jumped for a gun, but the birds flew by me at long range. One was brought down, but, as it was only winged, it managed to escape us in a bunch of heavy weeds before we could get over the two intervening fences. The other bird flew by out of range a couple of times, calling continuously, but, receiving no answer from its companion, it soon disappeared. The residents call this jay a “Jackdaw”.

114. *Dolichonyx oryzivorus* (Linnaeus). Bobolink

Summer visitant. The first published record of this species in Modoc County appeared in The Condor, Vol. XVIII, 1916, p. 28, where Mr. Leon W. Dawson mentions having come across a small breeding colony near Eagleville on June 30, 1912. That this colony is a permanent one seems to be now well established, for the Academy party found it in the same place in 1924 (Mailliard, 1924, p. 21), and residents of Surprise Valley stated that for many years the birds have been noticed there every spring. This seems to be the only part of the state visited by this species except as a rare straggler. Neither Dawson nor the Academy party actually found any nests, but there is little reason to doubt that the colony was nesting, or about to do so, when visited.
115. **Molothrus ater artemisiae** Grinnell. Nevada Cowbird

Rare summer visitant to Modoc County (Grinnell, 1915, p. 101). There is a specimen in the Museum of Vertebrate Zoology, Berkeley, California, taken at Brewer's ranch, 10 miles north of Alturas, June 8, 1910, when several others were also seen (W. P. Taylor, MS). Resident of Surprise Valley mentioned having seen this bird among the cattle from time to time, and gave such a detailed description of the bird as to make the generic identification unquestionable.

116. **Xanthocephalus xanthocephalus** (Bonaparte).

Yellow-headed Blackbird

Breeds in suitable places, but is not resident. A number were noted in meadows near Goose Lake in May, 1923, and a few were found in Surprise Valley in 1924, in May and June. On September 10, 1925, near Eagleville, I saw two birds of this species among a large flock of other blackbirds.

117. **Agelaius phoeniceus nevadensis** Grinnell.

Nevada Red-winged Blackbird

Common resident in suitable places. In September large flocks gather in the stubble fields, but they thin out very perceptibly by the middle of October. In 1925 these flocks of red-wings were of much greater size than were those of the previous year, being composed of thousands of birds, but in September, 1926, no very large flocks were seen. As with the crows above mentioned, this species appeared to be working south in comparatively small bands.

118. **Agelaius tricolor** (Audubon). Tricolored Red-wing

Noted in Modoc County in great numbers along the South Fork of Pit River, June 5, 1912 (Dawson, 1916, p. 28). Not noted in the county by Academy parties and no other record found. Incidentally, this red-wing is very uncertain in its local appearances.
119. *Sturnella neglecta* Audubon. Western Meadowlark

Common in all suitable localities in spring, summer, and fall, but not abundant. Probably some remain through a mild winter. These birds commence to band together by the end of September. On October 1, 1925, a flock of some 75 individuals alighted in a small field near where I was doing some bird banding.

120. *Icterus bullockii* (Swainson). Bullock’s Oriole

Common summer visitant in many localities, yet absent from others where one would naturally expect to find it. Nests in the willows and cottonwoods along the streams and irrigation ditches and in the planted poplar trees. Our earliest record of arrival was May 9, but it might have come into some of the canions a day or two earlier without our having come across it.

121. *Euphagus cyanocephalus cyanocephalus* (Wagler). Brewer’s Blackbird

Resident, but not at high altitudes. Common in limited numbers in all suitable places in the plateau region. Found nesting on the ground on top of the bank of a small stream at the Pit River Ranger Station, only a few rods from a tree- and bush-covered hillside. In September they gather in large flocks in the stubble fields with the crows. In 1925, especially, these blackbirds assembled in huge bands, almost as large as those of the red-wings. Some flocks contained both species, but the Brewer’s Blackbirds associated more with the crows than with the red-wings. By October 15 most of the birds had departed.

122. *Hesperiphona vespertina montana* Ridgway.
Western Evening Grosbeak

Warner Mountains in summer (Grinnell, 1915, p. 106). In early spring we found this species scattered in small bands about the county, feeding on willow and cottonwood buds.
A small flock stayed in the cottonwoods by the Deep Creek Forest Service Station, May 11-14, 1923. A flock appeared in Eagleville on September 24, 1924, and was feeding on the ground in the street. Also noted in September at higher altitudes, where several were taken.

123. **Carpodacus purpureus californicus** Baird.  
California Purple Finch


124. **Carpodacus cassinii** Baird. Cassin's Purple Finch

Warner Mountains, resident (Mus. Vert. Zool.). Noted by the Academy party in Jess Valley (5000 feet) only, where it was nesting, in June, 1923. Although I was constantly on the lookout for this species during the several visits made to Modoc County, I failed to note it anywhere else.

125. **Carpodacus mexicanus frontalis** (Say). House Finch

Warner Mountain region (Mus. Vert. Zool.). Resident over much of the plateau. Noted nesting at Cedarville, Eagleville, and Jess Valley. Very abundant in Surprise Valley in the fall of 1924 and 1925, when large flocks were a common sight along the roads.

126. **Astragalinus psaltria hesperophilus** Oberholser.  
Green-backed Goldfinch

Summer visitant. Evidently this finch was not much in evidence at the collecting stations of the Museum of Vertebrate Zoology party of 1910, although several individuals were noted at Sugar Hill on May 26, 1910 (W. P. Taylor, MS). It was noted by the Academy party in June, 1923, at the Pit River Forest Service Station and at Jess Valley, apparently nesting in both places. It was found by us at
Eagleville in small numbers toward the end of September, 1924, and it was quite numerous there in the fall of 1925 and 1926. Specimens secured.

127. *Spinus pinus* (Wilson). Pine Siskin

Summer visitant to the Warner Mountains (Mus. Vert. Zool.). A few pairs were noted by us at the Buck Creek Forest Service Station on May 25, and in Jess Valley in June, 1923. Small flocks were occasionally seen in Surprise Valley in September, 1924, and it was rather abundant there in the fall in 1925 and 1926.

128. *Passer domesticus* (Linnæus). House Sparrow

Several seen in the main street of Cedarville on September 12, 1924, as we were passing through in our car. None was noted during our stay in Surprise Valley in 1925, but a flock, estimated at 50 individuals, was feeding in the street of Adin as we passed through on October 15. I got out of the car and quietly approached to within 20 feet of the band before it took wing, when it flew into a garden bush close by. At Eagleville, September 21, 1926, a small band was seen in the street. House Sparrows were reported to have occupied an old barn on the main street of Eagleville for two or three years and then disappeared. It is rather interesting to know that these places are many miles from a railroad, which is supposed to be the line of extension of habitat of this sparrow, and are separated from one by mountain ranges.


Western Vesper Sparrow

Summer visitant, fairly common in the spring and very numerous in the early fall, at least, in Surprise Valley. By the end of September they have all left. A nest with four eggs was secured near Goose Lake on May 22, 1923.
130. *Pooecetes gramineus affinis* G. S. Miller.
Oregon Vesper Sparrow

An immature female vesper sparrow, taken at Steele Meadows by Dr. Joseph Grinnell on September 29, 1922, has been referred by him to this race. No other record.

Western Savannah Sparrow

A sparrow of this subspecies was taken at Eagleville on September 30, 1925, and another was secured there on September 21, 1926, these two being the only ones that were positively identified.

Nevada Savannah Sparrow

Common in summer in suitable meadows throughout the county. It was quite abundant in parts of Surprise Valley during the spring of 1924, and was either migrating or gathering for migration in September, flocks of from 50 to 100 individuals being noted where there was good feeding ground. Several endeavors were made to obtain a number of specimens in such places to ascertain if there were present any other races of Passerculus, but the birds were so difficult to secure in such cover as the rather high grass afforded that not much success rewarded our efforts. However, close observation led me to believe that there were few, if any, other forms present. By October the diminution in numbers was very perceptible. In the fall of 1925 the numbers present of this sparrow did not increase until about September 17, after which date they were quite abundant for a week or so. Very few were seen in the fall of 1926.

133. *Chondestes grammacus strigatus* Swainson.
Western Lark Sparrow

Summer visitant. Sugar Hill, June, 1910 (Mus. Vert. Zool.). A few pairs seemed to be preparing to nest at Cedar-
ville in May, 1923, and at the Pit River Ranger Station, but the species seemed to be scarce as a rule. It was not met with in the fall by Academy parties and apparently leaves early.


White-crowned Sparrow

Summer visitant to the higher elevations on the Warner Mountains (*Mus. Vert. Zool.*). Although a constant watch was kept for this bird on the floor of Surprise Valley (below 5000 feet) in the fall of 1924, no *leucophrys* was recognized. A better opportunity for determining its occurrence at the lower altitude presented itself in the fall of 1925, when I was trapping and banding numbers of *gambelii*, but none was taken. Contrary to this experience, this bird appeared in my traps in early September, 1926, when one was found in a trap on the floor of the valley on September 7. During the following week an occasional bird appeared, after which time no more were noted.


Gambel's Sparrow

A very abundant migrant in the fall and presumably equally so in the spring. It passes northward quite early in spring, and it appears that no collector has been on the ground until after the migration was practically over. Found to be extremely abundant in the fall of 1924, being present in limited numbers on September 3, the day of the arrival of the Academy party. The numbers increased rapidly for a week or so after this until there were more Gambel's Sparrows in evidence than I had ever seen anywhere before. The 17 miles between Eagleville and Cedarville seemed to have a flock of these sparrows every few rods along the road, wherever there was a sagebrush border. Had our party been prepared for such work, wholesale banding would have been an easy matter.

In the hope of finding conditions similar in this respect in 1925, Surprise Valley was revisited, with a banding outfit ready for work. A striking difference was found, however, in this year of normal rainfall as compared with the previous
year of great drought. Food and water were plentiful and the migrating birds were not so restricted in their choice of routes. In consequence of this, their numbers in Surprise Valley were far less. None was found until September 12, when one was secured and another seen. It was not until September 22, that enough of the sparrows had appeared to make it worth while to commence banding operations. With several interruptions caused by storms, etc., banding was kept up until October 10, by which time the sprouting grass seeds attracted the birds more than any bait offered to them, and so many had moved on southward that the work was discontinued. The banding was done by myself alone, with the following results: Adults banded, 200; immatures, 181; total, 381. In addition to this number there were 124 "repeats". Some of these repeaters came into the traps as many as three times in one day.

One of the main reasons for taking up fall work in Surprise Valley in 1926 was the checking up on returns of the sparrows of this species that were banded in 1925, particularly so because the season had been a dry one, much like that of 1924, when this sparrow was so numerous there.

In the 1926 fall field work, Modoc County was reached on August 28, and camp was made on the Pit River for a stay of a few days on the way to Surprise Valley. No sparrows of the genus *Zonotrichia* were noted at this time west of the Warner Range. In Surprise Valley the first were seen on September 2, when half a dozen were found in a hedge about two miles south of Eagleville. After this date the numbers rapidly increased until enough had appeared to warrant the commencement of banding operations on September 7, at the McCully ranch, two miles north of Eagleville. On this ranch was an ideal place in which to trap this sparrow, a spot where a large proportion of the banding of the previous year had been carried on. There were plenty of the sparrows here at this time, but there was so much weed seed, particularly that of a "pigweed", *Amaranthus*, that no bait that was offered proved much of an attraction. Later on this condition automatically bettered itself.

Three different banding stations were used and the traps moved from one to another as the ratio of repeats to new birds
taken became so large as to prove unprofitable in this "mass banding", until a new wave of migration came in. Two of these stations were quite close to Eagleville and both of them very nearly on a direct south line from the McCully ranch station, yet in no instance was a bird banded at one station picked up at another, which made it appear that when migrating birds left a resting place, they made a non-stop flight to another. Rather a small proportion of the birds that were banded came a second time into the traps, creating the impression that many of them made but a short stay in one spot in the height of the migration, their places as they left being filled by new arrivals. Yet a limited number evidently stayed on for a while, repeating after intervals of from two or three days up to a fortnight from the date of first capture, the latter being the case only among the first comers. Incidentally, some of the repeaters came many times into the traps, one of them appearing twice the first day, six times the third day, and, with two single entries, making ten visits in all inside of four days. The frequent moving of the traps from place to place, however, unfortunately interfered with close observation of arrivals and departures as would be indicated by such repeats, for, as soon as the "repeats" exceeded the number of new birds coming into the traps, operations were transferred for the time being to another station, on the principle that the greater number banded the greater the chance of some being picked up by other parties along the line of migration.

The results of these banding operations in the fall of 1926 were: Adults banded, 649; immature birds, 292; total, 941; percentage of adults to immatures being respectively, 69 and 31 per cent. In the previous year the ratio was 52 to 48, apparently indicating that more young had been raised in 1925 than in 1926.

In addition to the birds banded, there were 291 "repeats" (i. e. of birds but recently banded), but out of the 381 birds banded here in 1925, only four "returns" were taken, which was a great surprise. It is hard to say whether this paucity of "returns" indicated a great loss of birds in the past year, or only the selection of a different route of migration. Possibly it was a combination of both causes that brought about this result. It is interesting to note that the four "returns" were
taken in the identical localities in which they were originally banded.

The largest number banded in one day was on September 21, when 112 were banded and 26 repeats taken in the traps, making 138 captured on that date. This occurred in a temporarily unused feeding corral, half a mile from Eagleville, and about a mile and a half almost due south of the McCully ranch station, where there were many willow trees, a stream, and great patches of thistles that had gone to seed, making ideal cover and feeding ground for this sparrow. It was difficult at first to cultivate in the sparrows at this banding station a liking for the bait offered, but this was accomplished finally, and 80 were banded on the first day that the triggers of the traps were set. Unfortunately the supply of bands ran low and others ordered were delayed so in arrival that the most important week of the migration was lost.

The traps were moved to the third banding station, on the Minto ranch, in order to use up there the few bands (85) that remained on the evening of September 21, in the hope of incidentally picking up some “returns” at that station where so many birds had been banded in the previous fall, when no work had been done at the feeding corrals. A day and a half of banding used up the remaining bands.

The new supply of bands that had been expected for several days finally arrived on October 2, but by this time the feeding corrals were entirely deserted and there were so few sparrows remaining at the other two stations that operations were abandoned on October 6. There were yet quite a few birds remaining, however, at one spot on the McCully ranch, this being a vegetable garden in which was a dense patch of raspberry bushes, but a flock of quail and a family of stray chickens became so interested in the traps that an attempt to band there had to be given up.


Sparingly migrant in spring and fall. This species was found to be present in Deep Creek canón, above 5000 feet, on May 9 and 11, 1923, when some were seen by myself and one taken (Mailliard, 1924, p. 213). One of the main reasons for making Surprise Valley, Modoc County, the headquarters for
field work in 1924 was that of definitely ascertaining the status of this species east of the Sierras in northern California, as there were no published records concerning this matter. An unfortunate combination of circumstances prevented the party from reaching Modoc County in time for the regular migration of the genus Zonotrichia, but we were fortunate in securing one of the last stragglers of coronata, which was taken by Mr. Frank Tose, near Eagleville, on May 24.

A fall trip was made to this locality to investigate further this matter of occurrence, and Eagleville was reached on September 3 (1924). As stated above, Gambel's Sparrow was very abundant in this fall migration, and one of the most important of our duties was that of endeavoring to identify any coronata among the hosts of gambelii present. With birds that move along from bush to bush so rapidly as do these sparrows when followed by an observer, this was no easy task. Constant watching failed to discover any coronata until September 15, when two were noted at a spring close to the Nevada line east of Eagleville, and one of them was secured. They were with a flock of gambelii. Another was shot near Eagleville, September 17, but not retrieved, and one was taken September 18. After that date one or two were seen every day or so. Altogether seven were secured, three more lost, and 10 or 12 others were positively identified, the last one being on September 30. Endeavor was made to get some sort of an idea as to what percentage of the coronata might be present among the gambelii, but this was a difficult result to obtain. The former seems to be a more wary bird than the latter, and, as any observer knows, a flock of these sparrows, feeding on the ground, at the slightest disturbance makes a dive for the nearest shelter, which is never far away. Under such circumstances it was seldom possible to examine carefully every individual in it before the whole flock would jump up and disappear, whereupon the performance would have to be repeated as soon as the band again settled down to feeding. The nearest estimate that I could make was that the number of coronata present was probably about two per cent of the number of Zonotrichia under observation. Two individuals of coronata were found on a brushy hillside apart from any other
sparrows, and three were noted in similar circumstances in the settlement, but in the latter case there were flocks of gambelii not very far off.

In the fall of 1925 the first bird of this species was noted September 20, when a female was secured among some gambelii that were in Eagle Creek canyon near town. This band of Zonotrichia was very wild and rapidly moved out of our reach up the steep mountain side, evidently with no intention of tarrying in that locality. Both Denver and I were under the impression that there were other coronata in the flock, but the birds were too elusive for us to obtain proof of this.

During banding operations that fall, no coronata were noted until October 7, when two were taken and banded at the McCully ranch, 1½ miles north of Eagleville, two more were banded there on October 9, and one the next day, making a total of six positively identified during the fall work of 1925. The five coronata were among the 176 Zonotrichias banded at the one station, making a percentage of 2.8, or a little higher than my estimate of the previous year, but none was taken at the other banding station where work was carried on. These experiences show that an appreciable number of Golden-crowned Sparrows evidently accompany Gambel's Sparrows in the migrations of the latter east of the Sierras in northern California, but that the relative number is small.

In the fall of 1926 the first Golden-crown was noted on September 10, after which an occasional one was seen or came into traps as long as banding was carried on. The actual proportion of this species to the gambelii present was not worked out, but it seemed to be about the same as in the two previous seasons.

137. Spizella passerina arizoneæ Coues.
Western Chipping Sparrow

Very common summer visitant everywhere except, possibly, at the highest elevations. It either remains until late in the fall or migrates through the county at that time.
138. Spizella breweri Cassin. Brewer's Sparrow

Summer visitant almost anywhere in the sagebrush association, but not numerous until after the nesting season. It was fairly abundant in early September in the desert east of Eagleville, but had absolutely disappeared by the end of the month. These fall birds seem to be very wary and difficult to approach.

139. Junco oreganus thurberi Anthony. Sierra Junco

Common in all suitable places in spring, summer, and fall, but whether it is present during the winter is an unsettled question. People of Eagleville say that the "snowbirds" live around the settlement in winter, but these may be of another subspecies. If so, however, the time of arrival of such a race must be rather late, for careful observation up to October 14 failed to arouse any suspicion in my mind that there was any other form present among the many thurberi that fed close around our quarters in town, or among a lot that I examined at close range on the snow at the head of Granger Creek on the above date.

140. Amphispiza bilineata deserticola Ridgway.

Desert Sparrow

Found in summer on "both bases of Warner Mountains in Modoc County" (Grinnell, 1915, p. 121, and specimens in Mus. Vert. Zool.). Not noted by Academy parties at any collecting station.

141. Amphispiza nevadensis nevadensis (Ridgway).

Sage Sparrow

Summer visitant. Common, but not numerous, in the nesting season through the sagebrush association east of the Warner Mountains. Very common and rather numerous in the sagebrush on both sides of Surprise Valley in September, rapidly diminishing by the end of the month. In 1926 a few were still to be found as late as October 4.
142. Melospiza melodia fallax (Baird).
       Mountain Song Sparrow

       An adult female of this race was taken near Eagleville on September 20, 1926.

143. Melospiza melodia fisherella Oberholser.
       Modoc Song Sparrow

       Common in suitable places in spring, summer, and autumn, and possibly present to some extent in mild winters. In September, 1924, this sparrow was noted to be gathering in flocks of 30 to 40 individuals in places were there was good cover of dead weeds and plenty of seed softened by the rain. These bands were particularly scrutinized in an endeavor to find among them races of Melospiza other than fisherella, and a number of specimens were taken, but without result. In 1925 there was no noticeable assembling, and the song sparrows were much less abundant than in the previous year. Quite scarce in 1926.

144. Melospiza lincolni lincolni (Audubon).
       Lincoln's Sparrow

       Summer visitant. Breeds at the higher elevations on the Warner Mountains (Mus. Vert. Zool.). Two specimens were secured by the Academy party at Eagleville on September 8, another on September 11, 1924, and a female bird-of-the-year was taken September 30, 1925. Several other individuals of this subspecies were flushed but not secured.

145. Passerella iliaca schistacea Baird.
       Slate-colored Sparrow

       A female bird-of-the-year was secured on October 7, 1925, about a mile and a half north of Eagleville, under some heavy wild rose bushes among the sagebrush on the edge of the valley floor. An adult male of this race was taken on Sep-

       April 27, 1927
tember 14, 1926, near the summit of the Warner Range, about 13 miles southwest of Eagleville, at an altitude of nearly 8000 feet, and another at Eagleville on September 27.

146. *Passerella iliaca sinuosa* Ridgway. Valdez Fox Sparrow

A specimen of fox sparrow that appears to be most closely allied to this race was secured on September 19, 1924, beside a brushy streamlet at the eastern base of the foothills a few miles south of Eagleville. It seemed to be a lone straggler and is one of the two individuals of the *unalaschcensis* group of fox sparrows that were noted in this region, another having been taken on the foothills a little north of town on September 28, 1926.

147. *Passerella iliaca altivagans* Riley.

Alberta Fox Sparrow

A male bird-of-the-year was secured near Eagleville on September 30, and an adult male on October 4, 1926.


Warner Mountain Fox Sparrow

Summer visitant. Breeding along the Warner Mountains, so low down as the 5000 foot level on the western side of the range in Ceanothus association, but at higher levels on the eastern and more arid side. Apparently not very evenly distributed, as there were ten or twelve pairs around the Buck Creek Forest Service Station, practically all in the station horse-paddock of a few acres, but there seemed to be none anywhere else in the vicinity. More numerous higher on the range. One was secured on the floor of Surprise Valley, 4700 feet, on October 7, and another on October 14, 1925, but these were the only ones noted at so low an elevation on the eastern side of the Warner Mountains.
149. **Pipilo maculatus curtatus** Grinnell. Nevada Towhee

Common in summer in places on the Warner Mountains; Steele Meadows in the fall (Mus. Vert. Zool.). Common in Surprise Valley along the eastern base of the Warner Mountains, where it seems to be more numerous than in any other part of the county. Found well up on the mountains, for I noted a pair at an altitude of about 8000 feet.

150. **Oberholseria chlorura** (Audubon). Green-tailed Towhee

Summer visitant in all suitable localities in lower Transition.

151. **Hedymeles melanocephalus capitalis** Baird.

Pacific Black-headed Grosbeak

Common summer visitant. First one was noted by the Academy party among the willows and cottonwoods near Cedarville on May 11 (1923). Noted singing so late as August 9, at Dry Creek (W. P. Taylor, 1910, MS).

152. **Passerina amœna** (Say). Lazuli Bunting

Very common summer visitant to Upper Sonoran and Transition zones. Found even out in the extreme desert association in places where there is some water within reasonable distance.

153. **Piranga ludoviciana** (Wilson). Western Tanager

Common summer visitant to all the coniferous association in the county. Earliest date noted was May 15 (1923).

154. **Petrochelidon lunifrons lunifrons** (Say). Cliff Swallow

Summer visitant in the plateau region. A few were noted in Cedarville on May 12, 1923. They rapidly increased in number, and on the third day thereafter they were already busily engaged in building.
155. **Hirundo erythrogaster** Boddaert. Barn Swallow

Summer visitant. Clear Lake, April 4 and 17, 1918 (Willett, 1919, p. 200). Noted May 15, 1923, in Cedarville. We also found it nesting at Jess Valley in June of that year. A few were noted in Eagleville in May and June, 1924. Apparently common, but not numerous, over the plateau region.

156. **Iridoprocne bicolor** (Vieillot). Tree Swallow

Numerous in the mountains near Camp Bidwell in last of July (Henshaw, 1879, p. 2268). Apparently much less numerous at present time. Alturas, June 11, 1910 (Mus. Vert. Zool.); nesting in Jess Valley in June, 1923; noted at Eagleville, May 25 and September 20, 1924; and at Menlo Baths, four miles south of Eagleville, on October 1, 1926.

157. **Tachycineta thalassina lepida** Mearns. Northern Violet-green Swallow

Summer visitant to Transition zone, probably extending into Canadian, as it was taken at Warren Peak in July, 1910 (Mus. Vert. Zool.). Noted at Cedarville, May 13, 1923, and at Eagleville, May 26, 1924. On September 24, 1926, while I was banding birds near Eagleville, several of these swallows were seen flying about in an open field near by. With a .410 caliber collecting pistol I attempted to secure one or two for the record, but the strong wind then blowing made this almost impossible. A few were flying over the ponds at Menlo Baths on October 1, 1926.

158. **Bombycilla cedrorum** Vieillot. Cedar Waxwing

A small flock was seen in junipers near Clear Lake, April 8, 1918 (Willett, 1919, p. 206). The only time we met with this species in Modoc County was on September 20, 1924, when I secured a solitary male among some willows a little north of Eagleville. This makes only the fourth record of this bird in California east of the Sierras, yet residents of Eagleville state that this bird appears in winter in great numbers, to feed upon frozen apples that remain upon the trees in the small orchards around the settlement.
159. *Lanius ludovicianus excubitorides* Swainson.
   White-rumped Shrike

Common resident of the sagebrush areas. More numerous in the fall in Surprise Valley, either coming down from higher elevations or migrating southward.

   Western Warbling Vireo

Common summer visitant in Upper Sonoran and Transition zones. Found in practically every place visited in the spring.

161. *Lanivireo solitarius cassinii* (Xantus).
   Cassin’s Vireo

Summer visitant, common in suitable places in Transition zone. Noted at Sugar Hill in May; Parker Creek on June 20 and July 2; Dry Creek at end of July and up to August 3, 1910 (Mus. Vert. Zool.). Jess Valley in June, 1923 (Calif. Acad. Sci.). This species did not appear to be numerous anywhere.

162. *Vermivora ruficapilla gutturalis* (Ridgway).
   Calaveras Warbler

Common summer visitant in Transition zone. Sugar Hill and Parker Creek in May and June, 1910 (Mus. Vert. Zool.); “common about camp” at latter place (W. P. Taylor, MS). We took it at Cedarville on May 11, 1923, and found it common at Buck Creek Ranger Station on both visits.

163. *Vermivora celata lutescens* (Ridgway).
   Lutescent Warbler

Summer visitant in suitable association, common in nearly every place visited in the spring. Migrates southward commonly in the fall. Latest date of specimens taken was September 27 (1926).
164. **Dendroica aestiva brewsteri** Grinnell.
California Yellow Warbler

Common summer visitant. Found most frequently along streams or in willows. This warbler leaves for the south very soon after the young are reared. "Seen in abundance at Dry Creek August 2" (H. C. Bryant, 1910, MS). A few fall migrants from farther north noted in Surprise Valley and one or two secured by Academy parties.

165. **Dendroica auduboni auduboni** (J. K. Townsend).
Audubon's Warbler

Summer visitant, common wherever there are trees or willow growth of any size, though probably not breeding far away from actual timber. Numbers in the fall are increased by migrants from farther north.

166. **Dendroica nigrescens** (J. K. Townsend).
Black-throated Gray Warbler

Summer visitant to high Upper Sonoran and Transition zones (Mus. Vert. Zool.). A few noted at Jess Valley in June, 1923, but we did not come across this warbler elsewhere.

167. **Dendroica townsendi** (J. K. Townsend).
Townsend's Warbler

Rare migrant, possibly. I took a male in the Deep Creek cañon, May 13, 1923, and saw one or two at Cave Lake, in the extreme northern part of the county, at an elevation of over 7000 feet. There do not appear to be any other records for northeastern California.

168. **Oporornis tolmiei** (J. K. Townsend).
Macgillivray's Warbler

Common summer visitant in all suitable places.
169. *Geothlypis trichas occidentalis* Brewster.  
Western Yellow-throat

Commonly found as a summer visitant wherever there is a sufficient growth of tules, reeds, etc., to make attractive cover for this species.

170. *Icteria virens longicauda* Lawrence. Long-tailed Chat

Summer visitant in Upper Sonoran and lower Transition zones in riparian association, but not numerous. Cedarville, about the end of July (Mus. Vert. Zool.). We took specimens at Willow Ranch (Goose Lake) on May 28, 1923, and at Eagleville, May 29, 1924.

Pileolated Warbler

Summer visitant. "Summer specimens (in Mus. Vert. Zool.) from Sugar Hill, eastern Modoc County, are quite typical of *pileolata* and indicate the breeding of this race within the extreme northeastern corner of the state" (Grinnell, 1915, p. 152). In the spring of 1923 and 1924, warblers, supposedly of this race, were occasionally seen along the creeks in the bottoms of the cañons on the east side of the Warner Mountains, but none of us succeeded in securing any in the thick tangle which the birds inhabited, and they were so quick in their movements that it was exceedingly difficult to obtain a good view of them.

172. *Anthus rubescens* (Tunstall). Pipit

Spring and fall migrant. Rather common at Clear Lake in April, 1918 (Willett, 1919, p. 206). Noted on September 26, 1924, when several came to drink at a spring in the south end of Surprise Valley, and specimens secured. In early October, 1925, this species was occasionally noticed in the meadows near Eagleville, and on October 11 I saw several individuals along the road north of the village.
173. *Cinclus mexicanus unicolor* Bonaparte. Dipper

Common resident in the Warner Mountains (Grinnell, 1915, p. 153). An immature male was taken near Eagleville on September 18, 1924. Heard singing on September 20, 1925, in Eagle Creek canyon.


Sage Thrasher

Summer visitant to the sagebrush association in the plateau region. Not very numerous in the spring but abundant during the fall migration. The height of migration seems to be about the middle of September. At least, that was the case in Surprise Valley in 1924 and 1925. After that the numbers rapidly decreased. The last date on which it was noted was September 30 (1925), when we saw several and secured three specimens in a garden surrounding an old ranch house in the open meadow, a mile or more from any sort of appropriate cover for this species. The owner of the place had complained that there were some “strange birds” eating her strawberries. The marauders proved to be Sage Thrashers that found good cover in a gooseberry patch close by the strawberry bed. At this time there was a good-sized flock of *Zonotrichia l. gambelii* in the heavy growth of foliage in parts of this garden. An examination of this place a few days later showed that, in spite of the abundance of berries on the bushes and vines, no birds of any kind were then present.

175. *Salpinctes obsoletus obsoletus* (Say). Rock Wren

Summer visitant to rocky regions, without regard to altitude. Commonly found, yet not numerous at any place. Noted in September, 1924 and 1925, apparently migrating along the rocky mountain sides of Surprise Valley.

176. *Catherpes mexicanus conspersus* Ridgway. Cañon Wren

One individual was secured by W. P. Taylor at Dry Creek, July 30, 1910 (Mus. Vert. Zool., no. 5583), that has been provisionally placed under this head.
177. *Thryomanes bewickii drymæcus* Oberholser.
   San Joaquin Wren

   Resident in Upper Sonoran and Transition zones where good cover exists, but scarce in some parts. It is quite common in Surprise Valley, but not numerous in the spring. More abundant in the fall, either being driven out of the mountains by the snow, or migrating to a limited extent.

   Western House Wren

   Common summer visitant practically everywhere in the county. Noted in Surprise Valley as late as the middle of September.

179. *Nannus hiemalis pacificus* (Baird).
   Western Winter Wren

   On September 30, 1926, in company with Raymond Gilmore, I was looking for song sparrows at a small pond about six miles south of Eagleville, when a wren of this species suddenly appeared on the muddy edge of the pond. The bird was so close to me that I aimed, with the auxiliary barrel, a little to one side of it to avoid blowing it to pieces, but that little was just a trifle too much. The little wren was hard hit, but had sufficient energy left to enable it to flutter to some cat-tails six or eight yards from us, on one of which it clung for a moment and then fell among the trash that littered the surface of the water, where diligent search failed to discover it. The bird was close to us and in plain view in good light for sufficient time to admit of no doubt as to identification.

   Western Marsh Wren

   Summer visitant in marshy places, nesting wherever there is good cover of reeds, tules, etc.
181. Certhia familiaris zelotes Osgood. Sierra Creeper

Resident on Warner Mountains (Grinnell, 1915, p. 161). Not met with by Academy parties in the plateau region of the county, but presumably more or less present there during the period of heavy snow on the mountains.

182. Sitta carolinensis aculeata Cassin.
Slender-billed Nuthatch

Common on the Warner Mountains (H. C. Bryant and W. P. Taylor, MSS, specimens in Mus. Vert. Zool.). The only place in the spring that this nuthatch was noted by the Academy party was at Jess Valley, where a brood was being raised under the bark of a long-prostrate pine tree. Specimens from Jess Valley and Eagleville are in the collection of the California Academy of Sciences. In the fall commonly found at the lower levels.

183. Sitta canadensis Linnaeus. Red-breasted Nuthatch

Warner Mountains as summer visitant (Grinnell, 1915, p. 161). The field notes of the Museum of Vertebrate Zoology party of 1910 indicate an abundance of this species at the higher elevations of these mountains from June 27 to July 23. Seldom noted anywhere by Academy parties, which, however, did but little work at the higher levels. One specimen taken at Eagleville, September 3, 1926.

184. Sitta pygmaea pygmaea Vigors. Pygmy Nuthatch

Common resident on Warner Mountains (Mus. Vert. Zool.). Not met with at any place by the Academy parties.

185. Baeolophus inornatus griseus (Ridgway). Gray Titmouse

Scott's ranch, 10 miles southwest of Alturas, May 25, 1920, one specimen; Steele Meadows, September 27, 1922, two immatures (Mus. Vert. Zool.). "Rather common in junipers around Clear Lake" in April, 1918 (Willett, 1919,
Two specimens were secured near Eagleville on September 18 and 22, respectively, 1926, and another was seen by myself on September 21.

186. *Penthestes gambeli abbreviatus* Grinnell.
Short-tailed Mountain Chickadee

Resident almost everywhere in the coniferous forest, and often found in the willow association.

California Bush-tit

Common resident. While this species does not appear to be numerous in most places, it is fairly well distributed over the county. It has been recorded principally from the west side of the Warner Mountains (Grinnell, 1915, p. 165), but there is one record for Raider Creek, on the eastern side (Dawson, 1916, p. 29). We came across it on several occasions and secured specimens along the east side of these mountains, on the edge of Surprise Valley, both in May and September.

188. *Psaltriparus plumbeus* (Baird). Lead-colored Bush-tit

A male hornotine of this species, no. 28645, Calif. Acad. of Sci., was taken by myself near Eagleville, October 1, 1925. In the Museum of Vertebrate Zoology there is a male of this species, no 28639, M. V. Z., that was taken on Shields Creek, a few miles east of Alturas, July 24, 1926, by J. Linsdale, at an altitude of 5000 feet. These two specimens apparently constitute the northernmost record of this species for the state of California.

Two bush-tits, Nos. 26179, 26180, C. A. S., taken near Cedarville May 13, 1923, show distinctive characters closely approaching *plumbeus* and suggesting a cross between this species and *P. m. californicus*, but with less brown on the head than has any example of that race that I have examined. These two birds are the parents of set no. 4041, C. A. S. oölogical collection.
189. **Regulus satrapa olivaceus** Baird.  
Western Golden-crowned Kinglet


190. **Regulus calendula cineraceus** Grinnell.  
Western Ruby-crowned Kinglet

Summer visitant, most abundant during migrations. Canadian zone of the Warner Mountains (Mus. Vert. Zool.) during nesting season. Common at Clear Lake in early April, 1918 (Willett, 1919, p. 207). Present in limited numbers in Surprise Valley in the latter half of September, most abundant about the end of the month, at least, in the territory that was covered by my own observations.

191. **Myadestes townsendi** (Audubon). Townsend’s Solitaire

“Common resident of high Transition and Canadian zones on the Warner Mountains” (Grinnell, 1915, p. 169). Noted on many occasions by Academy parties at the higher elevations, and seen in Surprise Valley in the latter half of September, 1924, at times apparently in migration. A number were seen at various altitudes from 5000 feet up in Granger Cañon on October 14, 1925, at which time some of these birds were singing so vociferously as to be heard at astonishing distances in the still mountain air.

192. **Hylocichla ustulata swainsoni** (Tschudi).  
Olive-backed Thrush

Fairly common summer visitant to Modoc County in vicinity of Warner Mountains (Grinnell, 1915, p. 170). Noted at Goose Lake in May, and found quite numerous at Jess Valley in June, 1923, by the Academy party.
193. Hylocichla guttata guttata (Pallas).
    Alaska Hermit Thrush
    
    On October 4, 1924, near Eagleville, I secured a male bird-of-the-year, and another specimen (sex undetermined) was taken on September 16, 1926. In spite of this species being such a common winter visitant in so large a part of California, there seems to be no published record of its occurrence in the northeastern part of the state.

194. Hylocichla guttata sequoiensis (Belding).
    Sierra Hermit Thrush
    
    Common summer visitant to the Warner Mountains (Grinnell, 1915, p. 171). A female that was caught in one of my mouse traps at Happy Camp Forest Service Station on June 12, 1924, has such a slim bill as to be noticeable at first glance, but which seems to be in this case only a matter of individual variation.

195. Planesticus migratorius propinquus (Ridgway).
    Western Robin
    
    Common in summer in all suitable places. According to the statement of inhabitants of Eagleville, it remains through the winter in limited numbers.

196. Sialia mexicana occidentalis J. K. Townsend.
    Western Bluebird
    
    Common summer visitant, breeding sparingly in Upper Sonoran and Transition. More numerous in the fall, when it is often seen in company with the following species.

197. Sialia currucoides (Bechstein). Mountain Bluebird
    
    Summer visitant to the Warner Mountains, breeding in high Transition and Boreal zones. During migrations, especially in the fall, it is very abundant on the floor of Surprise Valley. The maximum of abundance was about the third week in September, after which the numbers rapidly grew less.
Hypothetical List of Birds

1. **Rallus virginianus** Linnaeus. Virginia Rail

   “Numerous about all the marshy lakes” (Henshaw, 1897, p. 2302). The text of Henshaw’s report on the ornithological part of the field work carried on by Party No. 1, California Section, of the Wheeler Geographical Survey in 1877-1878 shows that a stay was made at Fort Bidwell and work done in that vicinity, hence it seems to me proper to make mention of this rather indefinite record. This rail is not always easy to find and the fact that no further or more definite record of its presence has been published is no reason for believing that it is not at least a summer visitant to some of the marshes of the county. It is given by some of the authorities as common in summer *throughout the state*, but without definite records for Modoc County. It was not noted by any of the Academy parties.

2. **Totanus flavipes** (Gmelin). Yellow-legs

   This bird is a rarely identified migrant, and there are no recent records of its occurrence in northeastern California. Recorded as abundant at Rhett (now Tule) Lake in former years (Newberry, 1857, p. 98).

3. **Bartramia longicauda** (Bechstein). Upland Plover

   A bird of this species was shot at Tule Lake by Vernon Bailey on August 6, 1896 (Grinnell, 1915, p. 53). According to Doctor Grinnell, who made a special inquiry regarding this record (Cooke, U. S. Biological Surv. Bull. no. 35, 1910, p. 65), the wing only was sent to Washington for identification, but even that was not preserved. As the record gives only Tule Lake as the locality at which the bird was taken, and as this lake extends into Siskiyou County, California, and into southern Oregon, this record is not a very definite one, but it is the only one for California.
4. **Asio flammeus** (Pontoppidan). Short-eared Owl

“This owl was found to be common in the sedgy marshes about Warner Lake, Oregon, and doubtless inhabits similar localities throughout Eastern California and Nevada” (Henshaw, 1879, p. 2291). As Warner Lake (Crump Lake on recent maps) is only a few miles northeast of Surprise Valley, with no serious barrier intervening, Henshaw’s assumption that this owl inhabited parts of Surprise Valley seems of sufficient value to be worth mentioning here. Mr. James A. Street,—storekeeper at Eagleville, erstwhile cattle rancher, and ever an ardent and observing game hunter,—who was brought up in this valley, told me that he had sometimes flushed a rather large owl in the meadows and found it was nesting on the ground. Unfortunately we did not come across any, to prove the identity, but it must have been the Short-eared Owl.

5. **Coccyzus americanus occidentalis** Ridgway. California Cuckoo

Mr. James A. Street, whose statement was corroborated by others, stated that the California Cuckoo is often heard in Surprise Valley in midsummer, even in the village streets, but that it is extremely seldom one was seen. It is not heard before the end of June, but is commonly noticeable just before midsummer thunderstorms and is known by residents as the “rain crow,” a country name for the eastern bird of this genus. Mr. Street has watched for this bird and has seen and studied it. His description of the bird was sufficiently accurate to be easily recognizable and he knew the note well.

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Wetmore, Alexander

Willett, George

**Check-List of the Mammals**

1. Scapanus latimanus dilatus True
2. Sorex amanus Merriam
3. Sorex montereyensis mariposa Grinnell
4. Neosorex navigator navigator Baird
5. Myotis yumanensis sociabilis H. W. Grinnell
6. Myotis yumanensis altipetens H. W. Grinnell
7. Antrozous pallidus (pacificus?) Merriam
8. Procyon species
9. Mustela species
10. Mustela vizon subspecies
11. Spilogale gracilis saxatilis Merriam
12. Mephitis occidentalis major (Howell)
13. Taxidea taxus neglecta (Mearns)
14. Canis lewes Merriam
15. *Lynx fasciatus pallescens* Merriam  
17. *Otospermophilus grammurus douglasii* (Richardson)  
18. *Callospermophilus chrysodeirus chrysodeirus* (Merriam)  
19. *Citellus oregonus* (Merriam)  
20. *Ammospermophilus leucurus leucurus* (Merriam)  
22. *Eutamias amoenus amoenus* (Allen)  
23. *Eutamias townsendii senex* (Allen)  
24. *Sciurus douglasii albolimbatus* Allen  
25. *Glaucomys sabrinus flaviventris* Howell  
26. *Thomomys bottae leucodon* Merriam  
27. *Thomomys quadratus quadratus* Merriam  
28. *Perognathus nevadensis* Merriam  
29. *Perognathus parvus mollipilosus* Coues  
30. *Perognathus parvus olivaceus* Merriam  
31. *Dipodomys heermanni californicus* Merriam  
32. *Dipodomys ordii columbianus* Merriam  
33. *Microdipodops megacephalus oregonus* Merriam  
34. *Castor subauratus shastensis* Taylor  
35. *Onychomys leucogaster fuscogriseus* Anthony  
36. *Reithrodontomyys megalotis megalotis* (Baird)  
37. *Peromyscus crinitus crinitus* Merriam  
38. *Peromyscus maniculatus gambelii* (Baird)  
39. *Neotoma cinerea occidentalis* Baird  
40. *Microtus montanus montanus* (Peale)  
41. *Microtus montanus yosemite* Grinnell  
42. *Microtus mordax mordax* (Merriam)  
43. *Zapus major* Preble  
44. *Erithizon ephixanthum ephixanthum* Brandt  
45. *Ochotona schisticeps taylori* Grinnell  
46. *Lepus townsendii townsendii* Bachman  
47. *Lepus californicus wallawalla* Merriam  
48. *Sylvilagus nuttallii nuttallii* (Bachman)  
49. *Brachylagus idahoensis* (Merriam)  
50. *Odocoileus hemionus hemonicus* (Rafinesque)  
51. *Antilocapra americana americana* (Ord)

**General Account of the Mammals**

1. **Scapanus latimanus dilatus** True. Klamath Mole

The type locality of the synonymous *truei* is Lake City, Surprise Valley (Merriam, 1897, p. 102). This species is common, but apparently not abundant, in parts of the Upper Sonoran and Transition zones. There seems to be comparatively little surface evidence of its presence, even in damp places that appear to be eminently adapted to its mode of life.

The specimens secured by the Academy parties were mostly taken in small orchards or village gardens that were frequently watered. The meadows were usually found to be remarkably free from mole mounds, that are so damaging to the knives of mowing machines in haying time.

April 27, 1927
2. *Sorex amoenus* Merriam. Sierra Shrew

Shrews from Sugar Hill, and Parker and Dry creeks (Mus. Vert. Zool.) have been referred by Hartley H. T. Jackson (*in ep.*) to this species.


Specimens in the Museum of Vertebrate Zoology were taken at Parker Creek, at an altitude of 5500 feet (Grinnell, 1913a, p. 190). No examples were secured by the Academy parties.


A female of this species was taken at Parker Creek, June 19, 1910, by a field party from the Museum of Vertebrate Zoology.


In the Academy collection is a female taken on September 20, 1913, at the head of the South Fork of Pit River. It has been provisionally referred to this race, but is rather too dark to be typical. This constitutes the only record for the county.


Boreal zone of Warner Mountains (H. W. Grinnell, 1918, pp. 264-265). In the Museum of Vertebrate Zoology there are two specimens taken on the east face of Warren Peak at an altitude of 7800 feet, and in the Academy collection there is a male from the head of the South Fork of Pit River. Bats seem to be scarce in the county, as apparently very few have been noted by field parties that have worked in that region.
7. **Antrozous pallidus** (pacificus?) Merriam.

**Pacific Pallid Bat**

A specimen of *Antrozous* from Goose Lake, now in the Museum of the San Diego Society of Natural History, has been provisionally referred to *pacificus* (H. W. Grinnell, 1918, p. 355). No other record for the county.

8. **Procyon**, species

Tracks of a coon were noted at Parker Creek on June 25, 1910 (W. P. Taylor, MS). When Gilmore and Covel were trapping at Silver Creek, in the Swaringer Flat, a few miles southeast of Eagleville, tracks of a coon were noted around one of their traps, but the coon was not caught.

9. **Mustela**, species

In the afternoon of June 2, 1923, Ranger Ivan Cuff reported to me that he had just seen a weasel, carrying a young cottontail rabbit in its mouth, pass the Pit River Forest Station. On noting a spectator, the weasel had disappeared into an Oregon Ground Squirrel burrow near the building. We at once went to the scene and dug up the burrow for over 100 feet, but found no occupant except the owner, trying vigorously to dig in farther. As all the ramifications had been followed up, we could only conclude that the weasel had escaped during the few moments that Ranger Cuff had taken to notify us of the occurrence. The presence of this carnivore was reported by so many of the farming residents of Surprise Valley that there can be no doubt of its existence there. Occasionally weasels had been killed by farmers, but not at the time of our visits, and no remains could be found. No specimens were obtained by Academy parties.

10. **Mustela vison**, subspecies

In 1910 a lady was reported to have caught 15 mink on Parker Creek, near which she lived (W. P. Taylor, MS). In September, 1922, evidence of its presence was noted at
Steele Meadow, this being confirmed by cowboys and settlers (J. Grinnell, MS). Residents stated that up to 1924 mink had been noted or taken at Silver Creek, but that either they had been all trapped or the dry seasons had driven them to better feeding grounds, for none had been seen since that year. Several had been seen and some caught on the Bare Ranch in the winter of 1923-4, but this seems to have occurred in Lassen County, just beyond the Modoc line. Efforts were made by Academy parties to trap mink, especially along the Pit River, near the Pit River Forest Service Station, but the present scarcity of mink, or perhaps the abundance of food at the time, made these efforts of no avail.


Great Basin Spotted Skunk

"Extreme northeastern corner of the state in Upper Sonoran zone" (Grinnell, 1913b, p. 295). This skunk appears to be seldom noticed by residents of Modoc County, well adapted as it is for making its presence known. Possibly it is mistaken for young of Mephitis. At Pit River Forest Service Station an adult was taken, September 1, 1926, but it could not be saved as a specimen. A juvenile was secured near the same place, September 29, and added to the Academy's collection. Continued efforts were made to secure some specimens from Surprise Valley, but without success.


Great Basin Striped Skunk

Upper Sonoran and Transition zones of the county (Grinnell, 1913b, p. 295). Parker and Dry creeks (Mus. Vert. Zool.). Common, but not abundant, in Surprise Valley, where it was taken by the Academy field party in September, 1926.


Common in Upper Sonoran and Transition zones and casually in Boreal (Grinnell, 1913b, p. 296). On two occasions, near Eagleville, a large badger systematically robbed
one of our trap lines. The first theft took place on September 9, 1924, just after a light sprinkle of rain, and its tracks in the sandy soil showed that, accompanied by a companion not yet full grown, it had literally followed our footsteps from trap to trap. As there was abundant small rodent life in this locality, the traps were again strung out on September 15, on the chance of the badger not covering the ground that night, but the large one repeated the performance and was tracked to its hole, into which it was seen to disappear just in time to escape us.

During the several visits of the Academy parties to Modoc County, altogether aggregating nearly five months field work, these two occasions were the only ones when robbing of our traps of their contents was not confined to a trap or so now and then, and usually the robbery was of a cannibalistic character.


Quite common throughout the county. May be met with almost anywhere. I jumped one in a meadow near Eagleville, out of some grass that was barely high enough to hide it as it lay curled up on the ground. From the appearance of the grass, it was evident that the spot had been occupied for some hours.

The lair of this coyote was in the midst of a breeding colony of Nevada Red-wings. Warden G. W. Courtwright, now of Malin, Oregon, is quoted as stating that the coyotes take to the marshes in the spring, and there destroy numbers of game birds and eggs (Grinnell, MS).

On September 26, 1924, I visited some trappers living on the eastern side of Lower Lake, and there saw the skins of 18 coyotes that had been captured since the trapping season had opened a short time previously. These skins were mostly very large and in a fine state of pellage.

15. Lynx fasciatus pallescens Merriam. California Wildcat

Well distributed over the county as indicated by the specimens in the Museum of Vertebrate Zoology at Berkeley (Grinnell and Dixon, 1924, pp. 350-351).
16. **Marmota flaviventris flaviventris** (Audubon & Bachman).  
Yellow-bellied Marmot

Common in Upper Sonoran and Transition zones. Noted by Academy parties to be especially numerous near the southern end of Surprise Valley along the eastern base of the foothills of the Warner Mountains. Also abundant along the southern exposure of the gorge wall of the South Fork of Pit River, just below the western end of Jess Valley.

17. **Otospermophilus grammurus douglasii** (Richardson).  
Douglas Ground Squirrel

Commonly found in Upper Sonoran and Transition in many parts of the county, but nowhere sufficiently numerous as to be a very serious menace to crops or pasture.

18. **Callospermophilus chrysodeirus chrysodeirus** (Merriam).  
Sierra Golden-mantled Ground Squirrel

Common along the mountains above 5000 feet altitude, but not especially numerous.

19. **Citellus oregonus** (Merriam). Oregon Ground Squirrel

This rodent is so abundant from early spring until midsummer as to be a great pest over the plateau region of the county. Its food consists principally of green forage, of which the quantities consumed are very large compared with the size of the animal. It has been estimated that these squirrels on a thickly colonized square mile of pasture land consume, during the growing season of the grass, enough forage to support something like 90 head of cattle (Grinnell and Dixon, 1919, p. 635). Fortunately it hibernates as soon as the succulence is gone from the grasses, etc., disappearing from view between the last week in July and the middle of August, according to locality and conditions.

In Modoc County the scarcity of pocket gophers (*Thomomys*) was quite noticeable in areas fairly thickly occu-
pied by this ground squirrel, so much so as to suggest the idea of the former being driven out by the latter. In the late fall, after the disappearance of the Citellus, there seemed to be some invasion of its colonies by Thomomys, for in late September and early October fresh gopher sign was noticed and gophers caught in alfalfa fields among the then unused entrances to the burrows of what had been earlier in the season well-populated colonies of this ground squirrel. In spring and early summer I had failed to find any indication of the presence of gophers in these same colonies. It should be stated that the irrigation in the localities examined was not being carried on by the flooding system, and that during irrigation the rodent had excellent opportunities for escape from drowning.

20. Ammospermophilus leucurus leucurus (Merriam). Desert Antelope Ground Squirrel

At the time of the Academy party’s visit to Surprise Valley in the spring of 1924, no record of this species in northeastern California had been published, but there were specimens in the Museum of Vertebrate Zoology that had been taken in the desert on the eastern side of Surprise Valley.

Residents of the valley told us that this squirrel was abundant in the desert region. In 1924, however, its population was at a minimum and only two specimens were secured (Mailliard, 1925, p. 58). In the fall of 1925, it was more numerous than it had been in the previous year, but had not yet attained anything like the numbers stated by the settlers to represent its usual status.


This chipmunk is found to some extent in different parts of the plateau region of the county, as, for instance, Dry (Granger) Creek, and Alturas (Mus. Vert. Zool.); and Steele Meadow (Grinnell, MS). We found it in the desert region on the eastern side of Surprise Valley, opposite Eagleville, but it was not at all numerous. Several specimens were
taken there in the spring of 1924, but we did not succeed in securing many during the fall visits, when chipmunks that were probably of this species were occasionally seen scurrying from bush to bush, but which would not touch our baits and were too lively to be shot. Specimens were taken in September, 1926, in the sagebrush plain near the foothills on the western side of Surprise Valley.

22. Eutamias amoenum amoenum (Allen). Klamath Chipmunk

Common in the plateau region and on the Warner Mountains in suitable places. In some localities quite abundant.


Found on the Warner Mountains. Sugar Hill, head of Dry Creek, etc., (Mus. Vert. Zool). Not found at lower levels.

24. Sciurus douglasii albolimbatus Allen. Sierra Chickaree

Common in coniferous forest of Boreal zone in Warner Mountains (Grinnell, 1913b, p. 356). Specimens taken by Academy party at 7600 feet altitude, 12 miles southwest of Eagleville, in June, 1924.


Trinity Flying Squirrel

Transition and Boreal zones of the Warner Mountains (Mus. Vert. Zool.). This squirrel is so nocturnal in its habits that its presence often is unsuspected by residents of a locality in which it may occur, and there is good probability of its occurring also in other wooded districts of the county than those of the Warner Mountains.
26. **Thomomys bottae leucodon** Merriam.

White-toothed Pocket Gopher

This gopher has been recorded from Fall River Mills, in the northeastern corner of Shasta County (Bailey, 1915, p. 48), but possibly it has not heretofore been taken inside the Modoc County line. Specimens were secured by Academy parties in the Pit River valley near the Pit River Forest Service Station in June, 1923, and late August, 1926. Some of the specimens appear to be fairly normal *leucodon*, while one or two seem to show some sign of variation, as is so often the case with this subspecies.

27. **Thomomys quadratus quadratus** Merriam.

Dalles Pocket Gopher

Common on most of the plateau region and mountains. Many records. At no place visited by the Academy parties were pocket gophers found to be abundant. In fact, considering the amount of meadowland with a growth of wild grasses and alfalfa furnishing abundant food for this genus, it is remarkably scarce. Several times residents complained of the depredations of gophers in their gardens, but examination showed that the trouble was caused by moles, one of which can do a lot of damage in a garden in a very short time.

Mr. Frank Tose, of our party, passed four days, June 8-12, 1924, at a spring close by what is known as Clyde's cabin, about 12 miles southwest of Eagleville, on the Warner Mountain range at an elevation of some 7500 feet, and in restricted spots found gophers closely bunched together. In quick succession he caught two large adult males in one burrow opening near the cabin, the trap being set within a few inches of the surface of the ground, and three more males were taken in nearby burrows within 24 hours. Other duties prevented the giving of much time to trapping gophers, however, and no females were secured. The curious part of this incident is the catching of two males in such quick succession in one branch hole (not the regular runway), and the presence in so restricted an area of so many males at the same time.
28. **Perognathus nevadensis** Merriam. Nevada Pocket Mouse

On June 13, 1924, I found in one of my traps in the desert, three miles east of Eagleville, a male of this species of pocket mouse. As this was the first record of its occurrence in California, every effort was made to obtain other specimens during that visit to the county and in the fall as well, but with no further success. On September 12, 1925, however, a male and female were taken in the same locality as was the first, but at no other time was one found in our traps.

This species has been recorded from northern Nevada and southern Oregon desert regions, so that its presence in northeastern California is perfectly logical.

29. **Perognathus parvus mollipilosus** Coues.  

Coues's Pocket Mouse

Alturas (Osgood, 1900, p. 37). Warner Mountains (Mus. Vert. Zool.). Abundant along the base of the foothills on the west side of Surprise Valley, near Eagleville, and present to some extent in the desert region on the eastern side of the valley near the southern end of Middle Lake, as far as I have been able to identify the specimens taken by the Academy parties during several visits to this region. These specimens have been compared with a considerable series from the Warner Mountains, taken by Museum of Vertebrate Zoology field parties and now in that museum, and I am unable to distinguish the desert specimens from those taken in the mountains or on the western side of the valley. There seems to be more or less intergradation with *olivaceus*, both in color and skull characters.

30. **Perognathus parvus olivaceus** Merriam.

Great Basin Pocket Mouse

Lower Alkali Lake (Osgood, 1900, p. 38), one specimen identified from there. Lower Alkali or Lower Lake is only about a mile from Middle Lake above mentioned, and this specimen must have come from the same sort of association
as those obtained by the Academy parties. Probably it was an intermediate that happened to incline more toward this race than to *mollipilosus*.

   Northern California Kangaroo Rat

East side of Tule Lake, in the northwestern corner of Modoc County (Grinnell, 1922, pp. 40-41).

32. *Dipodomys ordii columbianus* (Merriam).
   Columbian Kangaroo Rat

Prior to the visit of the Academy field party of 1924 to Surprise Valley, no record had appeared of the occurrence of this subspecies in California north of Plumas County. As it belonged in the Upper Sonoran zone of neighboring states, it might have been "expected to occur generally over the lower sagebrush levels in the elevated northeastern corner of California" (Grinnell, 1922, p. 71), and this expectation on the part of Doctor Grinnell was verified as soon as we visited the desert adjoining the Nevada line (Mailliard, 1925, p. 57).

On the sand dunes in the desert, this kangaroo rat was present in considerable numbers, mostly along the tops of the brushy sand ridges. None of the colonies examined appeared to be very extensive, and, judging by the absence of tracks among them, many of the burrows were unoccupied. In spite of this, the total number of individuals living in this part of the desert must have been considerable as, without great effort and only trapping for them for a few days at a time, we secured over 40 specimens in this one locality, which was from 2½ to 3 miles east of Eagleville. During the various efforts of the Academy parties to obtain as many species as possible of the rodent inhabitants of this desert, it happened that few colonies of Dipodomys were discovered outside of this limited locality of less than one square mile, but there were large areas of desert that we had no opportunity to examine and which probably contained others.
33. Microdipodops megacephalus oregonus Merriam.
    Oregon Kangaroo Mouse

In close and apparently commensal association with the kangaroo rats in the desert, was found this race of Microdipodops, which had not previously been reported as occurring in California (Mailliard, 1925, p. 57). It seemed to be present, as far as it was possible to judge, in rather smaller numbers than the Dipodomys. On September 18, 1925, two specimens were taken in a part of the desert covered more or less with broken rock and where the soil was a sandy clay. This was about two miles east of the sand dune country. No individual of Microdipodops was found away from a Dipodomys habitat.

34. Castor subauratus shastensis Taylor. Shasta Beaver

According to the statement of Game Warden G. W. Courtwright, there were beaver on the Pit River near Alturas in 1922, as shown by dams and signs (Grinnell, MS). On September 30, 1922, Doctor Grinnell visited a colony of beavers, estimated to contain about 25 members, on Willow Creek, near Steele Meadows, but no specimens were secured.

35. Onychomys leucogaster fuscogriseus Anthony.
    Gray Grasshopper Mouse

High Upper Sonoran zone. Sugar Hill, Dry Creek, and Steel Meadows (Mus. Vert. Zool.). One taken by Academy party at Pit River Forest Service Station, September 26, 1926.

36. Reithrodontomys megalotis megalotis (Baird).
    Desert Harvest Mouse

One male immature was secured by the Academy party in the desert east of Eagleville on June 9, 1924; an adult male was taken in the same place, September 10, 1925, and three adults, a male and two females, were taken there, September 4 and 5, 1926.

Idaho Canyon Mouse

Upper Sonoran zone. Sugar Hill, Goose Lake and Dry Creek (Mus. Vert. Zool.). Found by Academy parties near Eagleville in the spring of 1924 and the fall of 1925, but only in restricted areas.


Gambel’s White-footed Mouse

Found all over the county and quite abundant at times, even out in the desert region in places.


Western Bushy-tailed Wood Rat

Common in the Transition and Boreal zones in suitable places. There is evidently a vertical migration of this species in the spring and fall. My own observations in spring developed much evidence of recent occupation of old buildings, hollow trees, rock slides, and lava “rim rock” formation at 5000 feet altitude and below, but, with the exception of two immature rats caught in an old hollow cedar tree at Buck Creek Forest Service Station, none was taken in May and June, even where the evidence showed that a large population had been present. The rangers stated that these rats were so numerous in the winter as to be a pest around old buildings, etc., coming down from the higher elevations with the advent of cold weather.

At the beginning of October, 1925, we set some rat traps in a very likely place in the mouth of Eagle Creek canyon where there was some evidence of occupation, but several nights trapping secured only one specimen of this wood rat, a very large old male. It seems as though this rat does not usually come down from the mountains until still later in the fall than early October, although at the time this one specimen was taken there was already considerable snow on the mountains, but the temperature was not very low. In the
Academy collection there are several adults taken by John Rowley at a high elevation on the Warner Mountains, September 21 to October 4, 1913. However, this migration seems to be affected by food or other conditions, for this rat was found in 1926 along the base of the Warner Range foothills in Surprise Valley as early as the end of August, and it was quite numerous through September, 1926. Weather at this time was relatively warm and free from heavy storms or serious snowfall on the mountains.

40. Microtus montanus montanus (Peale)
Peale's Meadow Mouse

Carr's Ranch, Rhett (Tule) Lake (Kellogg, 1922, p. 259; specimens in coll. Biol. Surv.).

41. Microtus montanus yosemite Grinnell.
Yosemite Meadow Mouse

This meadow mouse is usually present in most, if not all, of the meadows of any size in eastern Modoc County. The Museum of Vertebrate Zoology field party of 1910 secured specimens at many of its camps. On the other hand, the Academy party of 1923, although everywhere told what a pest this rodent was during the season for cutting the meadow hay, met with absolutely no success in finding it.

In Surprise Valley in May and June, 1924, some fresh sign was found near one old haystack, and some specimens were secured there, but apparently the drought of the previous winter had driven most of the meadow mice from the meadow to the tules of the laguna on the eastern edge of the valley, where they had taken refuge in a spot that was usually well covered with water (Mailliard, 1925, p. 103). The year 1923 was evidently one of extreme low ebb among the Microtus population of this part of the county, and the flood was just beginning in 1924.
42. *Microtus mordax mordax* (Merriam).
Cantankerous Meadow Mouse

Warner Mountains (Bailey, 1900, p. 50). Sugar Hill, Parker Creek, Warren Peak (Mus. Vert. Zool.).

43. *Zapus major* Preble. Warner Mountain Jumping Mouse

Transition and Boreal zones of Warner Mountains (Grinnell, 1913b, p. 342); Sugar Hill, Parker Creek, and Dry Creek (Mus. Vert. Zool). On May 18, 1923, three specimens were taken at Buck Creek Forest Service Station, but on no other occasion during that spring was this genus noted. One was secured in this same place on June 16, and one at Happy Camp Forest Service Station on June 18, 1924.

44. *Erithizon epixanthum epixanthum* Brandt.
Yellow-haired Porcupine

Very common throughout the coniferous forests of the county, and a very undesirable visitor in vegetable gardens and to wooden buildings. Its appetite for wood, especially where any salt or grease has been spilled, causes a great deal of destruction to old buildings. It also does much damage to forests by devouring the bark from the upper portions of the trunk of pine saplings. In many places a considerable percentage of the young growth of the pine forest is seriously injured in this way.

45. *Ochotona schisticeps taylori* Grinnell.
Warner Mountain Cony

Type locality is Warren Peak (9000 feet altitude), Warner Mountains, Modoc County (Grinnell, 1912, pp. 129-130). Sugar Hill (Mus. Vert. Zool.). Taken by the Academy party in the end of September, 1924, in large rock slide at an altitude of about 8000 feet and some 12 miles southwest of Eagleville, on the Warner Mountains. This small mammal usually, but not always, inhabits rock slides. In June, 1924,
while the Academy party was at the Happy Camp Forest Service Station, on the west side of the Warner Mountains, Ranger Ivan Cuff stated that he had seen conies in an old crater in the lava bed at Quaking Asp Spring, altitude about 4500 feet, about 12 miles west of the station. We visited this locality on June 18, but the weather was too dark and cold to entice the conies from their retreats. It was my intention to camp there and secure proof of this story, but the "spring", which was merely snow water in a cavity of the lava, was so nearly dry, and the road to the spot was so rough that the idea of moving camp to it was abandoned. However, Ranger Cuff evidently knows conies and their habits, and there is no reason to doubt his statement that he has heard, watched for, and seen the conies at Quaking Asp.

That this rodent is more numerous and more widely distributed in the county than was at first supposed is proved by the result of our own investigations and by the reports of hunters who were asked to be on the lookout for it. Fresh sign was found in several places along the Warner Range by Gilmore, Covel, and myself, from 5000 feet upward, one small colony being in the rocky bottom of Eagle Cañon, just before the cañon opens abruptly into the rolling plain, about a mile westerly from Eagleville. Another colony of conies was noted by Gilmore on a hill above the Pit River Forest Service Station in September, 1926, when examples were brought to me for identification. A large colony exists near the top of the Warner Range, a little southeast of Eagle Peak, at close to 9000 feet elevation, where several specimens were secured. This colony is about a mile north of the rock slide where the specimens above mentioned were secured in September, 1924.

46. Lepus townsendii townsendii Bachman.
Western White-tailed Jack Rabbit

Upper Sonoran and Transition zones of the Modoc region (Grinnell, 1913b, p. 395). Goose Lake (Nelson, 1909, p. 82). Parker Creek, Warner Mountains (Mus. Vert. Zool.). Nowhere abundant. I saw several in May, 1923, between Buck Creek Service Station and Goose Lake, but failed to secure
any. In 1926 the Academy party secured a specimen near Eagleville, September 19, and another near the Pit River Forest Service Station, September 27. Several were reported to have been seen in Surprise Valley at that time.

47. **Lepus californicus wallawalla** Merriam.  
**Washington Jack Rabbit**


48. **Sylvilagus nuttallii nuttallii** (Bachman).  
**Washington Cottontail**

Upper Sonoran and Transition zones in parts of the Modoc region (Grinnell, 1913b, p. 362). Noted by Academy parties in practically the same localities as was the Washington Jack Rabbit. The Academy collection includes specimens from South Fork of Pit River, Happy Camp, Jess Valley, Eagleville, and Cedarville.

49. **Brachylagus idahoensis** (Merriam). **Idaho Pygmy Rabbit**

Upper Sonoran zone. Recorded from Goose Lake (Nelson, 1909, p. 278). Not seen by Academy parties, although considerable search was made for it along the Nevada side of Surprise Valley, where it was reported to be present and where were found some burrows that appeared to have been occupied by this species.

50. **Odocoileus hemonicus hemonicus** (Rafinesque).  
**Rocky Mountain Mule Deer**

Modoc region (Grinnell, 1913, p. 367). Common in the mountain ranges, but not abundant at the present time. Does and fawns come down within a short distance of Eagleville, as
noted by myself. Near Quaking Asp Spring, in the plateau region, we startled a young fawn by the roadside. In the fall of 1926 the number of deer on the Warner Range had increased very perceptibly, seemingly as the result of an invasion from the Nevada mountains on the eastern side of Surprise Valley, where a large game refuge has been established. This invasion of the Warners was probably brought about by the scarcity of water on the Nevada side in this year of drought.

51. **Antilocapra americana americana** (Ord).

Pronghorn Antelope

Modoc region (Grinnell, 1913, p. 368). A band of about 125 individuals exists in the western part of the county, and ranges into Siskiyou County. It is fed upon hay to some extent in the winter season. This band is said to be slightly on the increase. According to the reports of farmers and cattlemen in the eastern part of the county, there are a few antelope that range from that region into Nevada.

**Hypothetical List of Mammals**

1. **Martes caurina sierræ** Grinnell & Storer.

Sierra Pine Marten

The presumed range of this race of pine martens includes the Warner Mountain range in Modoc County (Grinnell and Dixon, 1926, p. 415), but no specimens have been recorded from there.

2. **Canis gigas** (Townsend). Northwestern Timber Wolf

On October 2, 1922, Warden Courtwright stated that four wolves were "recently seen" near Straw (Grinnell, MS). These wolves probably came in from Oregon, as the species is practically extinct in California.
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XI
NEW SPECIES OF CEANOTHUS

BY
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Ceanothus cyaneus Eastwood, new species

Tall shrub with erect gray-green branches; leaves ovate-elliptical, thin, green on both surfaces, the upper glabrous, the lower when young somewhat pubescent, 1-2 cm. long, 1-1.5 cm. wide; margin glandular-denticulate, apex and base obtuse, petioles 2-4 mm. long; flowers in numerous large panicles 2-4 dm. long, terminating the branches, bracts conspicuous in bud, brown, striate, lanceolate-acuminate, appressed-pubescent, deciduous; flowers dark blue in bud becoming lighter in anthesis with yellow conspicuous anthers; pods deeply 3-lobed not crested; yellowish, veiny, glossy as if varnished.

This species is related to *Ceanothus thyrsiflorus* Esch., differing in the leaves, lighter green, thinner, less strongly veined and not revolute, the unusual color of the flowers and the yellow pods. It is certainly the loveliest of all the species of Ceanothus with its large sprays of beautiful blue flowers. On account of its unusual beauty it promises to become extensively cultivated and has already been introduced into cultivation by the nurserymen and seed dealers of southern California. It is a rapid grower according to Miss Sessions and

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blooms later than other species and almost continuously in cultivation.

*Type:* No. 139336, Herb. Calif. Acad. Sci., collected by Miss Myrtle Phillbrook at Lakeside, San Diego Co., Calif., at an elevation of about 1500 feet, in April, 1920, and sent to the California Academy of Sciences by Miss Kate O. Sessions whose attention was called to it by Miss Phillbrook and her brother.

*Ceanothus insularis* Eastwood, new species

Stiff, branching, shrub with gray or brown bark, the young branches clothed with fulvous tomentum: leaves opposite or closely alternate, elliptical, entire, obtuse, the pinnate veins and mid-rib fulvous tomentose and conspicuous on the finely canescent lower surface, upper surface bright green and glabrous, 2-4 cm. long, 1-1.5 cm. broad; flowers white or pale lavender with dark eye at the center formed by the disk and ovary; calyx about 6 mm. across, the divisions ovate acute, 3 mm. wide and with a central rib; umbels fulvous tomentose in bud on peduncles 1-1.5 cm. long; fruit about 8 mm. in diameter, without crests or inconspicuous ones low on the sides.

This species is closely related to *C. crassifolius*, from which it differs in leaves, flowers and pods. In his Botany of Santa Cruz Island (Bull. Calif. Acad. Sci., II, 393) Dr. E. L. Greene reported it as *Ceanothus crassifolius* Torr., probably on account of the prevailing opposite character of the leaves. It entirely lacks the dense white tomentose lower leaf surface of that species.

Flowering specimens were collected in the spring of 1919 on Santa Cruz Island by Mrs. Alonson Swain. Fruiting specimens were collected by the author on the same island, July 17, 1917 (Herb. No. 81312). Dr. Barton Warren Evermann collected it also on Santa Cruz Island in fruit, May 18, 1919. (Herb. No. 81311). Mr. Ezra C. Knapp collected it on Santa Catalina Island in both flower and fruit in the spring of 1926 (Herb. No. 139337). There are also flowering specimens in cultivation from seeds brought from Santa Rosa Island in our herbarium (Nos. 54885 and 54872).
Type: No. 81310, Herb. Calif. Acad. Sci., collected by Mrs. Alonson Swain on Santa Cruz Island, Calif., in the spring of 1919.

**Ceanothus utahensis** Eastwood, new species

Shrub, 2-3 dm. high, with rigid divaricately spreading dark gray puberulent branches often becoming thorny when old. Leaves elliptical, 1-2.5 cm. long, 5-1.5 mm. broad, entire, 3-nerved from the base, green and glabrate, the upper surface but little darker than the lower, apex obtuse, petioles 1-3 mm. long, puberulent, surpassed by the brown membranous evanescent stipules. Flowers white in short almost sessile racemes clustered at the ends of the branches, pedicels slender fascicled, 4-5 mm. long. Fruit unknown. This species belongs near *Ceanothus integerrimus* H. & A., but differs in the low spreading habit, almost sessile racemes and the leaves almost equally green on both surfaces. The racemes come from the old wood and almost every branch terminates in a flower cluster.

Type: No. 81309, Herb. Calif. Acad. Sci., collected by Alice Eastwood June 24, 1918, at Soldier's Summit, Central Pacific Railway, Utah.
XII

RECORDS AND DESCRIPTIONS OF WESTERN BUMBLEBEEs (BREMIDÆ)

BY

THEODORE H. FRISON


This paper is the result of an extensive study of the native western bumblebees contained in the collection of the California Academy of Sciences. Two forms, previously recognized but standing unnamed in my private collection, are herewith recorded and described because of the presence of similar specimens in the collection of the Academy. For the sake of convenience, this paper has been divided into three parts, the first dealing with synonymy, the second with distributional records, and the third with new descriptions.

For the loan of the material upon which this paper is based I am indebted to Mr. E. P. Van Duzee and Dr. E. C. Van Dyke. Individual collectors of the various specimens have not been specifically mentioned in each case. It will suffice, I think, to record that most of the material belonging to the Academy was collected by Dr. E. C. Van Dyke and Mr. E. P. Van Duzee, and that others who aided with the collecting or donated material were: A. J. Basinger, V. W. Owen, G. R. Pilate, J. R. Slevin, A. C. Pickett, O. C. Poling, J. A. Kusche, and C. L. Fox.

April 27, 1927
A. Notes on Synonymy

*Bremus sylvicola var. gelidus* (Cresson)


In 1921, after a careful study of the queen type from the Aleutian Islands now in the collection of the American Entomological Society at Philadelphia, I came to the conclusion that this form was not a distinct species but a color variety and an unusually large specimen of *Bremus sylvicola* (Kirby). The examination of considerable material since that time, particularly specimens in the collection of the California Academy of Sciences, confirms my earlier but unpublished opinion. Franklin, in 1913, although considering them as separate species, expressed an opinion that “I think it probable that they will some day be considered as mere color variants of the same species.” Like many other bumblebees, found in temperate and boreal climates, *Bremus sylvicola* (Kirby) displays considerable variation in color throughout its range. In fact, it is difficult to find many specimens exactly alike. All of these color varieties, however, that I have thus far seen, can be conveniently grouped under the following names: *Bremus sylvicola* (Kirby), *Bremus sylvicola var. lutsi* Frison, *Bremus sylvicola var. johanseni* (Sladen), and *Bremus sylvicola var. gelidus* (Cresson). I believe that further division would serve no useful purpose.

B. Distributional Records

1. **Bremus nevadensis** (Cresson)

*Yukon Territory*: Whitehorse, 2 queens, June 5. A new record for Yukon Territory, Canada.

2. **Bremus separatus** var. *mormonorum* (Franklin)

*Idaho*: Preston, 1 worker, July 17. The first record of this variety from Idaho.

3. **Bremus morrisoni** (Cresson)

4. Bremus crotchii (Cresson)

_California_: Santa Monica, 3 queens; Bear Valley, San Bernardino Mountains, 1 queen, July; Claremont, 1 queen; Huntington Lake, 7000 feet, 1 queen, one worker, July 28; Little Panoche Canyon, Kern County, 1 worker, May 22; Panoche Hills, Merced County, 1 worker, May 20; Ensenada Lake, 1 male, June, and Fresno, 4 males.

5. Bremus rufocinctus (Cresson)

_New Mexico_: Cloudcroft, 1 queen, August 5. _Vermont_: Huntsville, 1 worker, July 21.

6. Bremus occidentalis (Greene)

A large series of specimens of all castes from various western states. _California_: Meadow Valley, Plumas County, 3 queens, June 1 and 9; Fallen Leaf Lake, 1 queen, July 23; Carrville, Trinity County, 1 queen, June 10, 9 workers, June 10-29; Arcata, 2 workers, June 11; Sisson, 1 worker, 1 male, July 25. _Washington_: Longmire, Rainier National Park, 1 queen, 1 male, July 27; Paradise Valley, Mt. Rainier, 2 queens, 3 workers, July 15-25; Mt. Adams, 1 queen, 1 worker, July 3 and June 30; Lake Quinault, 1 queen, May 31, and North Bend, King County, 1 worker, July 10. _Oregon_: Olney, 1 queen, 1 worker, June 14-15; Mt. Hood, 5 queens, June 22-24; Steen Mt., Harney County, 3 queens, June 24-26; Corvallis, 1 worker, 2 males, June 11-15; Newport, 1 worker, June 8; Sparta, 2 workers, July 2; Colestin, Jackson County, 5 workers, July 30-31; Alsea Grade, Benton County, 7 workers, June 12-17. _Idaho_: Preston, 1 queen, 1 worker, July 15-19. _Utah_: Pine View, 1 worker, July 21. _Alberta_: Banff, 1 male, June 16. _British Columbia_: Victoria, 1 queen, June 28; Nanaimo, Biological Station, 3 queens, June 27-28.

7. Bremus occidentalis var. proximus (Cresson)

_Alaska_: Rampart, 2 queens, 3 workers, July; Savonoski, Naknek Lake, 1 queen, 2 workers, July 2, 1 queen, 4 workers, July 13; Seward, Kenai Peninsula, 1 male, May, 6 males, 1 worker, June; Skagway, 1 queen, May 22. _Washington_: Longmire, Rainier National Park, 1 worker, July 27.

8. Bremus occidentalis var. nigroscutatus (Franklin)

_California_: Contra Costa Co., 1 queen; San Francisco, 2 queens, October 9 and 28, 1 worker, August 27, 1 male, October 9; San Francisco, 4 workers, 3 males, August 27; Oakland, 5 workers, 1 male, July 11; Millbrae, 1 worker, August 25, 1 male, July 21, 7 males. September 1; Sobre Vista, 11 workers, October 2-6, 5 males, May 9, 32 males, October 2-6; Berkeley, 2 workers, September 9; San Mateo County, 1 male, September 29; Carmel, 1 male, October 8.
9. Bremus edwardsii (Cresson)

A large series of all castes. California: Sobre Vista, Sonoma County, 13 queens, January 21, June 22, November 21 and 24, 2 males, April 30 and May 8, 12 workers, February 17, March 19, April 6-30 and May; Carmel, 6 queens, January 27, February 9-23, May 1, June 10, October 25, 1 queen, February, 4 workers, May 18, 20; Meadow Valley, Plumas County, 6 queens, June 1-8, July 2, 3 males, June 7-14, 2 workers, June 5; Porterville, 1 queen, November 9; Claremont, 1 queen; San Francisco, 1 queen, January 26, 2 males, April 20, May 10, 2 workers, April 28, April 20; Carville, 16 males, May 31, June 7-29, July 1, 3 workers, June 13-25, July 1; Santa Cruz Island, 10 males, May 16-18, June 1; Silver Lake, Plumas County, 4 males, June 19; Sacramento, 1 male, May 28; Marin County, 1 male, April 23; Yosemite Valley, 7 males, May 17, 22, June 7-21; Kean Camp, 5 males, 1 worker, June 6-12; Muir Woods, 2 males, May 4, 21; Pismo, 2 males, April 25; Crystal Lake, San Mateo Co., 1 male, May 7; Nellie Lake, Fresno Co., 1 male, July 25; Yorkville, 1 worker, May 1; Lake Tahoe, 1 worker, June 22; Huntington Lake, 1 worker, July 6, 1 queen, July 9; Nash Mine, Trinity Co., 1 worker, June 13; Ukiah, 1 male, May 10.

10. Bremus vosnesenskii (Radoszkowski)

Oregon: Hood River, 2 queens, June 12; Olney, 2 queens, June 15-16; Waldport, 1 queen, 6 workers, June 5; Jacksonville, 1 worker, 1 male, July 14; Ashland, 1 male, August 2; Crater Lake, 2 queens, July 17. Washington: Hoquiam, 1 worker, May 26. California: Norval Flats, Lassen Co., 1 queen, May 30; Santa Cruz, 1 queen, October 23, 3 workers, June 1; Yosemite Valley, 1 queen, May 16, 1 worker, June 10; Berkeley, 1 queen, May, 1 queen, October 9, 2 workers, May, 1 worker, September 9, 1 worker, May 12, 1 worker, June 6; San Francisco, 1 queen, July 2, 2 queens, March 30, 2 queens, April 20, 1 worker, October 9, 1 worker, April 28, 2 workers, April 20, 1 worker, May 10, 1 worker, August 2, 1 male, August 27, 1 male, August 27, 1 male, July 2; Inverness, 1 queen, June 11; Soboba Springs, 1 queen, June 3; Carmel, 1 queen, November 17, 11 workers, June 9-25, 1 worker, August 21, 1 worker, June 23, 2 workers, August 6, 1 worker, May 29, 4 workers, July 4-17, 1 worker, July 6; Fallen Leaf Lake, 1 queen, July 14, 1 queen, June 20, 1 worker, July, 2 workers, July 18-23; Carville, 1 queen, 4 workers, June 3-29, 1 worker, May 31, 1 worker, July 1, 1 male, July 1, 1 male, June 10; Martinez, 3 queens, 2 workers, May 2, 1 queen, June; Muir Woods, 2 queens, May 4; San Mateo, 1 queen, June 15; Bubbs Creek, 1 queen, July 9; South Fork of King's River, 1 queen, July 4; Sobre Vista, 2 queens, September 23-25, 2 workers, 3 males, May 8-9, 28 males, October 2-6, 2 males, September 1-20; McCloud, 1 queen, June 19; Meadow Valley, 1 worker, June 21, 2 males, July 1; Gilroy Hot Springs, 1 worker, May 30; Mesa Grande, 1 worker, July 10, 1 worker, July 17; Fairfax, 1 worker, May 11; Huntington Lake, 1 worker, June 21, 8 workers, July 5-12; Scotia, 1
worker, June 12; Arcata, 1 worker, June 11; Mount Tamalpais, 1 worker, April 6, 1 worker, August 27; Strawberry Valley, 1 worker, 1 male, August 5; Seaside, 6 workers, July 12; Bear Valley, San Bernardino Mountains, 1 worker, July; Oakland, 1 worker, June 7, 4 males, June 30; Kean Camp, 1 worker, June 6-12; Santa Monica, 1 worker, 1 male, July; Cayton, 1 worker, July 12; Preston, 2 workers, 2 males, July 19, 1 male, August 27; Lagunitas, 1 worker, June 25; Nash Mine, Trinity Co., 1 worker, June 13; Mount St. Helena, 1 worker, June 9; Reading, 1 worker, July 6; Laurel Dell, 1 male, August 3; Cisco, 1 male, July.

11. Bremus bifarius (Cresson)

*California:* Mt. Kaiser, 9000 feet, 1 male, July 19.

12. Bremus bifarius var. vancouverensis (Cresson)


13. Bremus bifarius var. kenoyeri (Cockerell)

*Oregon:* Steen Mountains, 4 queens, June 24-25. *Utah:* Park City, 2 queens, July 2-3; Mount Timpanogos, 1 queen, July 8; American Fork Canyon, 1 queen, July 25.

14. Bremus bifarius var. nearcticus (Handlirsch)

*California:* San Francisco, 3 queens, April 20; Paradise Valley, Fresno Co., 1 queen, July 16; Pyramid Peak, Eldorado Co., 1 queen, August 8; Truckee, 1 queen, July 20; Fallen Leaf Lake, 1 queen, 7 workers, July 13-25, 1 queen, June 20, 1 queen, June 17; Huntington Lake, 9 workers, July 3-17; Eldorado County, 4 workers, 1 male, August 8, 9; Bullfrog Lake, Fresno Co., 3 queens, 1 worker, July 10; South Sonoma Co., 1 worker, May 1; Lake Tahoe, 1 worker, June 22; San Mateo County, 1 worker, July 7, 1 male, June 15; Silver Lake, Plumas County, 2 males, June 19; Cisco, 2 males, July; Shasta County, 1 male, June 26. *Oregon:* Crater Lake, 3 queens, July 17-18; Fremont National Forest, 1 queen, June 18; Warner Mountains, Lake County, 1 queen, June 19; Mount Hood, 5 queens, June 11-26; Sparta, 1 queen, 2 workers, 1 male, July 2; Steen Mountains, 1 queen, July 5; Wallowa Mountains, 1 queen, 1 male, July 5. *Washington:* Paradise Valley, Mount Rainier, 1 queen, 2 workers, July 18-25; Mount Adams, 1 worker, July 3. *Alberta:* Banff, 1 worker, June 16. The first definite records of this variety from California, Washington and Alberta.

15. Bremus sylvicola (Kirby)

*Alberta:* Banff, 1 queen, June 16. *Alaska:* Nome, 7 queens, July; Savonoski, Naknek Lake, 1 worker, July 2-19, 2 males, July 4; Makushin Bay, Unalaska Island, 2 workers, July 15; St. Paul Island, Pribilof Islands, 1 queen, June.
The presence of one queen of this species in the Academy collection from St. Paul Island, Pribilof Islands, is surprising. Previous to this record only one species of bumblebee had been recorded from the Pribilof Islands. Furthermore, according to Dr. G. Dallas Hanna “bumblebees are confined solely to St. Paul Island of the Pribilof Group. During seven summers spent up there I have never seen one elsewhere, and the natives, who are quite familiar with the bees, are positive in their assertions that the facts are as stated” (Proc. Calif. Academy of Sciences, 4th Ser. Vol. XI, 1921, p. 186). Mr. George Haley, who presented this specimen to the Academy, states that it was taken by him personally from flowers of lupine at the “wells” a mile from the settlement on St. Paul Island and, as he took no more bees on that trip, there can be no possible error as to locality. However, it must not be overlooked that *Bremus sylvicola* occurs on the mainland of Alaska and in the Aleutian Islands.

16. *Bremus sylvicola* var. *gelidus* (Cresson)

*Alaska*: Makushin Bay, Unalaska Island, 2 queens, July 14; Dutch Harbor, Unalaska Island, 3 workers, August 13, July 7; Mount Dewey, 8 males, August 19; Skagway, 4 workers, July 14-August 7.

17. *Bremus melanopygus* (Nylander)

*Oregon*: Olney, 2 queens, 2 workers, 13 males, June 8-15; Newport, 1 queen, 1 male, June 8; Mount Hood, 1 queen, June 22; Alsea Grade, Benton Co., 2 males, June 12; Marshfield, 1 male, June 12; Waldport, 4 males, June 5. *Washington*: Paradise Valley, Mt. Rainier, 18 queens, 25 workers, July 15-25; Forks, 2 workers, 1 male, July 5; Lake Quinault, 7 workers, 1 male, May 30, 31; Port Angeles, 1 worker, May 26. *Alaska*: Seward, 1 queen, 7 workers, June 1; Savonoski, Naknek Lake, 6 workers, July 5; Skagway, 2 queens, May 15-22, 1 queen, 1 worker, July. *California*: Meadow Valley, 1 male, June 19. *Alberta*: Banff, 2 workers, June 16. *British Columbia*: Nanaimo, 5 queens, 4 workers, June 22-28. A new record for California.

18. *Bremus frigidus* (F. Smith)

19. **Bremus mixtus** (Cresson)

*Alaska*: Skagway, 5 queens, May 14-22. *British Columbia*: Nanaimo, 1 queen, June 24. *Washington*: Paradise Valley, Mt. Rainier, 2 queens, July 15, 25; Seattle, 1 queen, 4 workers, 1 male, June 16, 19; North Bend, King County, 6 workers, 6 males, July 8-10; Hoquiam, 8 workers, May 29; Quiniault, 2 workers, May 30; Forks, 1 male, July 2. *Oregon*: New port, 3 queens, 6 workers, 1 male, June 8; Olney, 10 workers, 4 males, June 14-16; Corvallis, 1 worker, June 12; Waldport, 3 workers, 5 males, June 5; Alsea Grade, Benton County, 3 males, June 12; Colestin, 1 male, June 30. *California*: Crescent City, 2 workers, 2 males, July 24, 25; Huntington Lake, 1 worker, 1 male, July 6, 27; Meadow Valley, Plumas County, 1 male, June 19, 2 males, July 2-8; Strawberry Valley, Eldorado County, 1 male, July 7, 1 male, August 13; Carrville, Trinity County, 1 male, June 28.

20. **Bremus flavifrons** (Cresson)


21. **Bremus flavifrons** var. *dimidiatus* (Ashmead)

*Washington*: Forks, Callam County, 1 queen, July 1; Humptulips, 1 worker, 1 male, May 28, 29; North Bend, King County, 5 males, July 10; Monroe, 1 male, July 4-15; Fork Hoh River, 1 male. *California*: Sisson, 1 male, July 24; Norval Flats, Lassen County, 1 male, July 18; Sequel Creek, Santa Cruz Co., 1 male, May 30. New distributional records for Washington and California.

22. **Bremus flavifrons** var. *ambiguus* (Franklin)

*California*: Nash Mine, Trinity County, 5 queens, June 13; Pyramid Peak, Eldorado County, 1 queen, August 8; Bubbs Creek, King River, 2 queens, July 9; Carrville, Trinity County, 1 queen, June 29; Fallen Leaf Lake, 1 queen, July 21; Strawberry Valley, Eldorado County, 1 queen, August 10. *Washington*: Lake Quiniault, 1 queen, May 30.

23. **Bremus pleuralis** (Nylander)

*Alaska* Seward, Kenai Pen., 1 queen, June.

24. **Bremus centralis** (Cresson)

*Oregon*: Fremont National Forest, 7 queens, June 18; Steen Mountains, Harney County, 2 queens, June 23-26; Warner Mountains, Lake County, 2 queens, 1 worker, June 20; Crater Lake, 1 worker, July 19; Sparta, 2 workers, July 2; Wallowa Mountains, Baker County, 1 worker, July 5.
25. **Bremus centralis var. monardae** (Cockerell)

*California:* Sobre Vista, Sonoma County, 8 males, June 22-23, 4 males, July 10, 1 male, July; Carrville, Trinity County, 4 males, July 1; Huntington Lake, 2 males, July 27. The first definite record of this variety from California.

26. **Bremus sitkensis** (Nylander)

*Alaska:* Skagway, 4 queens, May 12-22, 1 queen, July 29, 2 workers, May 22, July 23, 1 male, August 7; Mt. Dewey, 2 males, August 19; Seward, Kenai Peninsula, 2 males, June. *Oregon:* Waldport, 2 queens, 9 workers, 5 males, June 5-6; Olney, 8 workers, 2 males, June 14-15. *British Columbia:* Nanaimo, 1 queen, 11 workers, June 22, 28; Victoria, 1 male, June 28. *Washington:* Paradise Valley, Mount Rainier, 1 queen; Forks, Clallam County, 12 workers, 9 males, July 2, 5; Seattle, 2 workers, June 16-19; Hoquiam, 3 workers, May 27; Paradise Valley, Mount Rainier, 1 worker, 1 male, July 20; Quinault, 10 workers, 2 males, May 30, 1 worker, June 1; North Bend, King County, 2 workers, 1 male, July 9, 10. *California:* Santa Cruz, 1 worker, May 21; Scotia, 2 workers, June 12; Oakland, 1 worker, February 19; Pescadero, 1 male, June 4; Sequimville, Sonoma County, 1 male, May 30; Inverness, 1 male, June 11, 2 males, May 22; Muir Woods, Marin County, 1 male, May 2.

27. **Bremus polaris** (Curtis)

*Alaska:* Nome, 2 queens, 2 workers, July.

28. **Bremus hyperboreus** (Schönherr)

*Alaska:* Makushia Bay, Unalaska Island, 2 queens, July 14-15; Beach Bay, 1 worker, 1 male, September.

29. **Bremus appositus** (Cresson)


30. **Bremus fervidus** (Fabricius)

*Utah:* Salt Lake City, 1 queen, June 24; Kings Station, Davis County, 1 worker, July 24.
31. Bremus fervidus var. dorsalis (Cresson)

Oregon: Sparta, Baker County, 1 queen, July 2; Steen Mountains, Harney County, 1 queen, June 24. The first definite record of this variety from Oregon.

32. Bremus californicus (F. Smith)

British Columbia: Victoria, 1 worker, June 28; Nanaimo, 2 queens, June 22. Oregon: Sparta, 1 worker, July 2; Olney, 3 queens, June 14, 15; Newport, 1 queen, 1 worker, June 8; Colestin, 1 worker, July 31; Corvallis, Mary's Peak, 1 queen, June 4. Washington: Seattle, 2 queens, June 16-19; North Bend, 1 queen, July 10. California: Panoche Hills, 1 queen, April 30; Meadow Valley, 4 queens, June 14-30; San Luis Obispo, 1 queen, April 26; Fremont National Forest, 3 queens, June 18; Carmel, 1 queen, October 11; Oak Glen Lodge, San Bernardino Mountains, 1 queen; Contra Costa County, 1 queen, April 16; St. Monica, 1 queen, 1 worker, July; Claremont, 1 queen, May 22; Berkeley, 1 queen, May; Sobre Vista, 1 queen, 1 worker, 4 males, July 10-17, 3 workers, September 1; Martinez, 2 workers, June 12; Cazadero, 5 males, September 2; Inverness, 1 male, June 11; Keen Camp, 1 male, June 6-12; Preston, 1 male, July 19; Soboba Springs, 2 males, June 2-5; Mesa Grande, 1 male, July 10, 1 July 17.

33. Bremus californicus var. dubius (Cresson)

British Columbia: Victoria, 1 queen, June 27. Washington: Seattle, 1 queen, June 16. California: Oakland, 1 male, June 7; Sobre Vista, 1 male, July 10. The first definite record of this variety from British Columbia.

34. Bremus sonorus (Say)

Arizona: Baboquivari Mountains, 2 queens, October and September 15, 2 queens, 3 workers, August 18-20, September and October, 5 males, October 3 and November-20, 1 male, October 16; Ramsey Canyon, Huachuca Mountains, 1 queen, July 10, 1 worker, June 13; Santa Rita Mountains, 1 worker, June 4, 2 workers, July 10, 11 workers, August 7; Patagonia Mountains, 2 workers, August 1 and 2; Cochise County, 1 worker, June 26; Oracle, 2 workers, July 27. California: Playa del Rey, 1 queen, October 16, 1 worker, October 3, 5 queens, May 31 and June 5; Claremont, 1 queen; St. Monica, 1 queen, 3 workers, July; Riverside, 1 worker, September and 1 worker, June.

35. Psithyrus suckleyi (Greene)

Washington: Forks, Clallam County, 1 queen, July 5. Utah: Vivian Park, 1 queen, July 7. Oregon: Wallowa Mountains, Baker County, 1 queen, July 5; Warner Mountains, Lake County, 1 queen, June 20; Mount Hood, 3 queens, June 22 and 23.
36. *Psithyrus insularis* (F. Smith)

*British Columbia:* Nanaimo, 5 queens, June 23-27; Victoria, 1 male, June 28. *Alaska:* Savonoski, Naknek Lake, 2 queens, 2 males, July 4-21; Mount Dewey, 2 males, August 19; Skagway, 1 queen, May 11. *Oregon:* Newport, 1 queen, June 8; Wallowa Mountains, Baker County, 3 males, July 5. *Washington:* Port Angeles, 1 queen, May 26; Monroe, 1 male, July 4-14. *Utah:* Aspen Grove, 1 male, August 20; Boy's Camp, Logan County, 1 male, September 7.

37. *Psithyrus crawfordi* Franklin

*California:* Yosemite, 1 queen, June 19; Fallen Leaf Lake, 1 queen, June 29, 3 males, May 22; Shasta, 1 male, July 23; Meadow Valley, Plumas County, 8 males, June 5-21 and July 1, 2; Martinez, 2 males, May 2; Huntington Lake, 2 males, July 6 and 17; Silver Lake, Plumas County, 1 male, June 19; Strawberry Valley, Eldorado Co., 1 male, August 9; South Fork, King's River, 1 male, 5000 feet elevation, July 5. *Oregon:* Newport, 1 male, June 8.

38. *Psithyrus fernaldae* Franklin

*Washington:* Paradise Valley, Mount Rainier, 4 queens, 1 male, July 7, 15, 23; Longmire, 5 males, August 12; Forks, 8 males; July 2, 5; Lake Quinault, 1 male, May 30. *Oregon:* Walport, 9 males, June 5, 6; Newport, 2 males, June 8; Marshfield, 8 males, June 11, 12, 14, 19. *California:* Eureka, 1 male, July 25.

39. *Psithyrus fernaldae* var. *wheeleri* Bequaert and Plath

*California:* Yosemite Valley, 1 queen, May 25; Meadow Valley, Plumas County, 2 males, June 7; Strawberry Valley, Eldorado Co., 1 male, July 7. *Oregon:* Mount Hood, 2 queens, June 22, 24; Waldport, 6 males, June 5; Marshfield, 3 males, June 12, 13.

C. Descriptions

**Bremus edwardsii russulus** Frison, new variety

*Worker.* Structurally identical with the worker of *edwardsii* (Cresson) [= *fernaldi* Franklin]. Differs from typical specimens of *edwardsii* (Cresson) in having the pubescence upon the dorsum of the fourth segment mostly ferruginous in color and that on the fifth and sixth dorsal segments with a golden color.

Paratypes, workers: 1, Meadow Valley, Plumas County, California, 3500-4000 feet altitude, June 4, 1924 (E. C. Van Dyke); 1, Yosemite Valley, California, June 9, 1921 (E. C. Van Dyke); 1, Lake Tahoe, California, June 22, 1925 (E. H. Nast); 1, Huntington Lake, Fresno County, California, 7000 feet altitude, July 6, 1919 (Mrs. E. P. Van Duzee).

Bremus crotchii nigricaudus Frison, new variety

Queen. Structurally identical with the queen of crotchii (Cresson). Differs from typical specimens of crotchii (Cresson) in having the pubescence on the apical dorsal abdominal segments entirely black, or at least with only a faint suggestion of a ferruginous tinge.


The paratype is smaller than the holotype and it is possible that it may be a large worker instead of a queen. Less specialization has evidently taken place between workers and queens in this subgroup of the genus than in others. This variety is recorded as “Color Variant 1” by Franklin (1913), but not given a varietal name.

Bremus flavifrons vandykei Frison, new variety

Worker. Structurally identical with the worker of flavifrons (Cresson) as redescribed by Franklin, 1913, except that the malar space is slightly shorter. Differs in color characters from typical specimens of flavifrons (Cresson) and its varieties flavifrons dimidiatus (Ashmead) and flavifrons ambiguus (Franklin) as follows: Pure yellow pubescence above and below bases of antennae and on occiput. Dorsum of thorax with a clearly defined wide black band between wings, anterior dorsal portion of thorax with pure yellow pubescence,
and scutellum mostly yellow. Pubescence on second dorsal abdominal segment, except yellowish hairs on its posterior margin and lateral posterior corners, almost entirely black; third segment entirely covered with yellow pubescence; lateral margins of fourth segment fringed with some yellowish pubescence. Hairs fringing corbiculae entirely black.


The proper status of this form has proved a puzzle to me. Superficially it resembles Bremus edwardsii (Cresson). It may be easily separated from that species, however, by the fact that the first and fourth dorsal abdominal segments are mostly covered with black pubescence. The form we are now considering as Bremus bifarius var. nearticus (Handlirsh) somewhat resembles vandykei, but the comparatively shorter malar space of the former offers a good character for their separation. The length of the malar space of the variety vandykei is somewhat suggestive that this form may be entitled to specific recognition. My decision to consider vandykei a variety rather than a new species is based upon the fact that the two specimens just described are the only ones of a similar character that I have ever seen. Furthermore, Bremus flavifrons (Cresson) is exceedingly variable in color characters. Bremus flavifrons var. ambigius (Franklin) somewhat approaches vandykei in color characters and is frequently found in collections from Washington. Biological studies of Bremus flavifrons (Cresson) are needed to throw light upon the limits of color variation in this species.

I take pleasure in naming this variety for its collector, Dr. E. C. Van Dyke, to whom the Academy is mainly indebted for the development of its collection of bumblebees.

Bremus caliginosus Frison, new species

Male. Identical in coloration with the male of Bremus vosnesenskii (Radoszkowksi) as redescribed by Franklin (1913). Differs structurally from that species as follows:
Malar space almost twice as long as its width at articulation of mandible, at least two-thirds as long as greatest width of, and slightly over one-fourth length of, the eye. Third and fifth antennal segments of almost equal length, fourth much shorter than either.

Illustrations

(Camera lucida drawings by Mrs. K. H. Paul)

Fig. 1. *Bremus caliginosus* new species, outer spatha.

Fig. 2. *Bremus caliginosus* new species, inner spatha.
Fig. 3. Bremus caliginosus new species, genitalia, dorsal aspect.

Fig. 4. Bremus caliginosus new species, heads of sagittæ.

Outer spatha (Fig. 1) about like that of Bremus sitkensis (Nyl.), without prominent median indentation on posterior margin such as is found in Bremus vosnesenskii (Rad.). Inner spatha (Fig. 2) about like that of Bremus sitkensis (Nyl.), without prominent median indentation on posterior
margin of caudal projection such as is found in *Bremus vosnesenskii*.

Inner apical point of volsella (Fig. 3) more conspicuous than outer apical point, a condition reversed in the case of *B. vosnesenskii*. Inner apical angle of squama (Fig. 3) broadly rounded, this being more pointed in *B. vosnesenskii*. Shafts of sagittae (Fig. 3) straighter than in *B. vosnesenskii*, and with sickle-shaped heads (Fig. 4) dilated instead of narrow as in *B. vosnesenskii*.

*Holotype*: male, taken by C. D. Duncan, September 16, 1920, at Arcata, California, in collection of the author. Paratypes, males, 1, Monterey, California, June 21, 1921 (L. S. Slevin); 1, Lagunitas, Marin County, California, June 25, 1924 (E. H. Nast); 2, Carmel, California, May 16 and June 19, 1921 (L. S. Slevin), 2 May 24 and July 11, 1925 (L. S. Slevin); 1, Mt. St. Helena, Napa County, California, June 9, 1918 (E. P. Van Duzee); 2, Sobre Vista, Sonoma County, California, June 22, 1910 (J. A. Kusche); 2, Requa, California, August and September 13, 1920 (C. D. Duncan); 1, Brookings, Oregon, July 9, 1923 (G. A. McGinnis); 1, Corvallis, Oregon; 1, "W. T." (= Washington); 1, Mt. Sideo, twelve miles northwest, Carson, Washington, October 21, 1918 (A. C. Burrill); 1, Kings Valley, Oregon, July 18, 1905 (Vincent); 1, Vancouver, Washington, August 14, 1907 (Nettie Currin); 1, Alsea, Oregon, August 2, 1921 (H. A. Scullen); Gold Beach, Oregon, July 10, 1925 (H. A. Scullen).

Nine paratypes in the collection of the author. Seven paratypes in the collection of the California Academy of Sciences. Four paratypes in the collection of the Oregon Agricultural College. The antennae of one paratype from Sobre Vista, California, are abnormal in that the seventh, eighth and ninth segments are much enlarged.

This species is undoubtedly standing in many collections under the name of *Bremus vosnesenskii* (Radoszkowskii). I first became aware of the existence of this form in 1921, while making a comparative study of the genitalia of the North American species of this genus. A description of the species was not published at that time because of the poor condition of the two specimens then in my possession and the
desire to see additional material. The series of eighteen specimens just recorded is sufficient to indicate that the characters of this form are constant and easily serve to distinguish it from the form we are now calling *vosnesenskii* (Radoszkowski). I have examined hundreds of the males of this latter species and have found no evidence of a transition between it and *Bremus caliginosus* Frison.

Undoubtedly the workers and queens of this species mimic in color those of *Bremus vosnesenskii* (Radoszkowski). I have tried to definitely locate and separate the workers and queens of *vosnesenskii* and *caliginosus*, without satisfying results. At least, I have not been able to point out any tangible characters for their separation by others. The solution of this problem must probably await the examination of additional material or specimens from a single nest in which all castes are represented.

The male of this new species is easily recognized from *Bremus vosnesenskii* (Radoszkowski) by its longer malar space, differences in comparative lengths of third, fourth and fifth antennal segments, and the greatly dilated sickle-shaped heads of the sagittae. All these characters indicate that *Bremus caliginosus* Frison is a member of the *sitkensis-flavifrons* complex rather than of the *huntii-vosnesenskii* complex of the subgenus *Pratobombus* Vogt.

**Bremus caliginosus tardus** Frison, new variety

*Male.* Structurally identical with the male of *Bremus caliginosus* Frison as described in this paper. Differs in coloration from *Bremus caliginosus* Frison by having the dorsal abdominal segments entirely covered with black pubescence.

*Holotype:* male, No. 2438, Mus. Calif. Acad. Sci., collected by L. S. Slevin, July 20, 1921, at Carmel, California.

This variety of *Bremus caliginosus* Frison is readily separable from *Bremus vosnesenskii* (Radoszkowski) by the lack of yellow pubescence upon the dorsum of the fourth abdominal segment.
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XIII
EXPEDITION OF THE CALIFORNIA ACADEMY OF
SCIENCES TO THE GULF OF CALIFORNIA IN 1921

THE CHRYSOMELIDÆ (COLEOPTERA)

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In the following pages are listed the Chrysomelidæ taken by the 1921 Expedition of the California Academy of Sciences to the islands of the Gulf of California. The lot sent me for determination by Mr. E. P. Van Duzee of the Academy comprises some 43 species, of which 9 are described as new. One or two others are very likely undescribed, but lack of sufficient material, or the difficulty of recognizing the already described Mexican species prevents doing more at this time than to refer these to their proper genera. With a single exception, the species all belong to known genera, and a large majority have been previously recorded from the Sonoran fauna of our southwestern border States, or from the Lower California Peninsula. With but very few exceptions the specimens were all collected by Mr. Van Duzee himself, the few remaining having been taken by his assistant, Mr. J. C. Chamberlin.

1 A map showing all the islands, etc., visited may be found in the General Report of this Expedition by Joseph R. Slevin, Vol. XII, No. 6, pp. 55-72, of these Proceedings. Copies can be supplied at nominal cost.

2 This paper is No. 37 of the Gulf Expedition series.

April 27, 1927
1. **Megalostomis pyropyga** Lacordaire

San Pedro Bay, Sonora, July 7, three examples. This large and showy insect is a common Mexican species, and is not rare along our southern boundary in Arizona.

2. **Coscinoptera mucorea** Le Conte

A considerable series of conspicuously uniformly white pubescent specimens from numerous localities, are separable into two unequal lots; one (the greater number), having a humeral red spot, the other (3 examples only) without trace of such spot. The specimens with red humeral spot are undoubtedly the species which Horn in his Baja California paper identified as *mucorea* Lac. A fair proportion of the specimens are typical *mucorea* with entirely black legs; others have the tibiae feebly reddish varying to clear red; the sculpture also varies independently of the color of the legs from that of typical *mucorea* to the denser coarser punctuation, which with the red tibiae is typical of *schaefferi* (*tibialis* Schf.). There can hardly be a doubt that the series with red humeri represents but a single species, and the inference is strong that *schaefferi* possesses no more than varietal standing.

The nearly typical *mucorea* are from the following localities: Puerto Refugio, Angel de la Guarda Island, May 1; and Pond Island Bay, same island, July 1.

Nearly typical *schaefferi*, San José Island, May 29; Tiburon Island, July 3.

Various intermediates—Tortuga Island, May 11; Coronados Island, May 18; San Francisco Island, May 30; San Marcos Island, June 17.

3. **Coscinoptera inornata** Fall, new species

The three examples without red humeral spot, mentioned above, may perhaps also belong with the preceding species, but for the present I prefer to separate them under the above name. They have the same robust form as *mucorea*, and aside from the lack of the humeral spot show no tangible differences, unless we except the elytral punctuation, which is considerably coarser than in typical *mucorea*, and is about
as in *schaefferi*. The surface lustre is evidently, though not strongly, aeneous and the legs are entirely black. Length 4.6-5.5 mm; width 2.25-2.75 mm.


4. *Coscinoptera æneipennis* Le Conte

Tiburon Island (Willard’s Point Bay), July 3, a single specimen. This striking species occurs along our southern border from California to western Texas, and in the adjacent parts of Mexico.

5. *Euryscopa alicula* Fall, new species

Elongate, subcylindrical, black, shining; head, thorax, body beneath and legs densely ashy white pubescent, concealing the surface except along the middle of the pronotum, where the sculpture is partially revealed; elytra each with a broad reddish yellow stripe extending from the base to about the apical third, involving externally the humeral umbo and subhumeral lobe, becoming narrower and rounded at its posterior end, leaving the suture narrowly, and a small scutellar triangle, black. Head sparsely and finely punctate. Prothorax varying from slightly shorter to slightly longer than wide, sides feebly arcuate and subparallel in more than basal half, gradually convergent anteriorly; surface finely sparsely punctate on the disk, with a narrow impunctate median line, sides more coarsely and quite closely punctate. Elytra suboblong, moderately narrowed behind, a little more than ½ longer than wide, and from ½ to ¾ longer than the thorax; striae unimpressed, composed of rather fine punctures, which become subobsolete at apex; intervals flat and sensibly smooth. Dimensions—(type) 3.6x1.75 mm.; smallest specimen 3.2x1.5 mm.; largest specimen 4.15x1.95 mm.

*Type:* No. 2427, Mus. Calif. Acad. Sci., collected by E. P. Van Duzee, July 1, 1921, at *Pond Island Bay, Angel de la Guarda Island*. 8 paratypes, Puerto Refugio, Angel de la Guarda Island, May 1, 1921.

This species must be closely allied to *subtilis* Horn, but a specimen sent to Mr. Liebeck of Philadelphia for comparison with the Horn type was reported as distinct therefrom
in his judgment, being less elongate, with much more densely pubescent thorax and less oblique elytral vittæ, leaving a much smaller scutellar triangle.

6. **Euryscopia subnigra** Schaeffer

San Marcos Island, May 12; San José Island, May 28-29, June 10; Carmen Island (Puerto Ballandra), May 21; Mar-quer Bay, May 23. Eight Examples.

The Carmen Island specimens lack the small red spot beneath the humeral umbo, but as this varies in development in those that have it, its absence appears not to be significant.

7. **Babia quadriguttata pulla** Lacordaire

Guaymas, Sonora, April 19; nine examples.

8. **Babia humeralis** Fabricius

Monserrate Island, May 25; San José Island (Amortajada Bay) May 28-29; Conception Bay, Lower California, June 17. Nine examples.

9. **Saxinis microstriga** Fall, new species

Of about the same size and nearly as stout as *sonorensis*; black, with distinct dark green or blue green lustre, elytra with red humeral spot precisely as in *omogera*; entire surface minutely alutaceous yet moderately shining.

Head rather sparsely finely punctate, punctures longitudinally coalescent only near the eyes. Prothorax gradually broadly arcuately convergent from the base, nearly evenly finely punctate throughout, the punctures separated by one to two times their diameters, becoming noticeably larger and closer only near the side margins; interspaces with extremely minute punctules on a strigoso—alutaceous ground. Elytra slightly more than twice as long as the prothorax and \(\frac{3}{4}\) longer than wide, sides nearly parallel in the female, a little convergent behind in the male; striae of moderate punctures regular and feebly impressed laterally, scarcely impressed and much confused in about the inner third; interspaces with single rows of small punctures; scutellum sparsely punctured, chiefly in two irregular longitudinal rows. Body beneath rather densely clothed with short, ashy, appressed hairs. Length 5-6 mm.; width 2.8-3.4 mm.

Described from five examples—
Type ♀ from Santa Rita Mts., Arizona, in my own collection, and four paratypes (1 ♂, 3 ♀s) from Guaymas, Sonora, April 15; San Pedro Bay near Guaymas, July 7.

Except that the Mexican specimens are a little larger, I am unable to detect any difference between them and the Arizona type. This species runs to omogera in Schaeffer's table, but the five examples before me differ constantly from both eastern and Arizona specimens of omogera by the peculiar minute longitudinal strigosity of the thorax. In omogera the thorax is merely very finely punctulate between the larger punctures.

10. Saxinis inæqualis Fall, new species

Not very robust; head and thorax shining blue green, glabrous; elytra black with faint bronzy green lustre, surface shining and with short, sparse, semierect whitish pubescence; there is an inwardly quadrate red humeral spot, which involves the entire epipleural lobe, and attains the middle of the elytron in a transverse scuse. Head finely not closely punctate, intervals polished. Thorax about 3⁄4 wider than long, sides broadly arcuate and gradually, not very strongly, converging from the base; surface sparsely finely punctate at middle, very much more coarsely and closely so near the lateral margins; intervals extremely minutely very feebly punctulate, strongly shining. Elytra twice as long as the prothorax, barely 3⁄4 as wide as long, fairly regularly punctate striate, the striae feebly impressed, intervals with irregular punctures, which are nearly as strong as those of the striae. Body beneath densely ashy pubescent as usual. Length 4.3 mm.; width 2.25 mm.

Type: No. 2428, Mus. Calif. Acad. Sci., collected by E. P. Van Duzee, April 15, 1921, at Guaymas, Sonora.

The glabrous thorax and sparsely pubescent elytra ally this species to subpubescens Schf. It is considerably less robust than the latter, which is much more coarsely punctate throughout and with duller surface lustre. This species must approach more closely the Mexican hirtipennis, but the latter is said to be of broad flattened shape, and to have the sides of the thorax strongly rounded and the anterior angles produced into a blunt point.
11. *Saxinis vestiaria* Fall, new species

Moderately robust, dull black, faintly greenish, elytra with a red humeral spot involving the epipleural lobe and extending to just within the humeral umbo; rather conspicuously clothed, except the head, with short recumbent cinereous pubescence. Head moderately punctate, punctures not coalescent except near the upper margins of the eyes. Thorax as wide as the elytra at base, sides either subparallel basally, or just perceptibly converging forward in basal half, more strongly so in front; punctuation rather fine, not dense, the punctures separated at the middle by rather more, and at sides by a little less, than their own diameters. Elytra less than \(\frac{1}{2}\) longer than wide, feebly to scarcely narrowed behind, surface very densely, confusedly, subrugosely punctate throughout, the punctured striae scarcely detectable at any part; scutellum less closely punctate. Body beneath densely cinereo-pubescent. Length 5-6 mm.; width 2.75-3.2 mm.

*Type:* No. 2429, Mus. Calif. Acad. Sci., collected by E. P. Van Duzee, April 15, 1921, at Guaymas, Sonora.

Sonora, April 15. This species is much more conspicuously pubescent than either *subpubescens* or *knausi*. In form it is rather less stout than the former, but more robust than the latter. It differs from both by the very dense rugose punctuation of the elytra, with barely a trace of the usual punctured striae. The Mexican *hirtipennis* is said to be metallic greenish blue with shining thorax, and the elytra distinctly punctate striate.

12. *Chlamys mimnonius* Lacordaire

Guaymas, Sonora, April 9, one example.

13. *Chlamys prosternalis* Schaeffer

Guaymas, Sonora, April 9; one example.

The carina of the metascutellum is very acute throughout, becoming broader and flattened only at the extreme base. Schaeffer, in his description, says “broad at base and sharply carinate behind.”

14. *Exema conspersa* Mannerheim

Guaymas, Sonora, April 11; two examples.
15. *Pachybrachys wickhami* Bowditch

Angeles Bay, Lower California, June 25; a single example.

16. *Pachybrachys xanti* Crotch

San Marcos Island, May 12 and June 19; Escondido Bay, Lower California, May 24; three examples.

17. *Pachybrachys sp.*

A single female specimen from Mulegé, Lower California, May 15, resembles *diversus* Fall rather strongly and may belong to that variable species, which is hitherto known to me from Illinois to New Mexico. In any case it cannot properly be described without the male.

18. *Pachybrachys xanthochrous* Fall, new species

Of rather small size, rufotestaceous throughout, without trace of spots or markings at any part, the head and thorax of slightly darker tint than the elytra, surface minutely alutaceous. Head not densely punctate, ocular lines feebly indicated close to the eyes, the latter separated by about $\frac{1}{4}$ the length of the basal antennal joint in the male, and by the length of this joint in the female. Antennæ (♂) reaching nearly the middle of the elytra, the 10th joint a little more than twice as long as wide, outer joints dusky at tips. Prothorax (♂) $\frac{3}{4}$ wider than long, sides broadly arcuate throughout, moderately converging apically, surface closely strongly punctate over the greater portion of the disk a little more sparsely and unevenly so at middle, side margins narrowly smooth. Elytra confusedly punctate in a rather small basosutural area, elsewhere with distinct well impressed striæ, of which the fifth and sixth are somewhat confused at middle; eighth with the usual subbasal dislocation; marginal interspace impunctate. Front claws of male moderately enlarged, in the female visibly so. Length (♂ type), 2.8 mm.; width 1.4 mm. The female allotype is slightly larger and stouter as usual.

*Type:* Male, No. 2430, and allotype, female, No. 2431, Mus. Calif. Acad. Sci., collected by E. P. Van Duzee, April 10, 1921, at Guaymas, Sonora.

This species must be referred to section B of my Revision, and there runs to *longus.* The entire absence of spots will,
if constant, distinguish it from longus, in which the form is a little more slender, the color a paler yellow, the punctures and striae brownish, the standard spots faintly indicated.

19. Pachybrachys alacris Fall

Agua Verde, Lower California, May 26, a single example. Originally described from Arizona; only females are known thus far.

20. Pachybrachys indifferens Fall, new species

Dull yellow, distinctly alutaceous and scarcely shining, punctures and striae brown, the female with small standard spots on the elytra, these lacking in the male; head and thorax in both sexes with standard markings, faint in the male, more distinct in the female. Head sparsely irregularly brown punctate; ocular lines fine, close to the eyes; eyes separated by a little less (♀), or a little more (♂), than the length of the basal antennal joint. Antennae fully attaining the middle of the elytra (♂), somewhat shorter (♀), outer joints more or less dusky apically. Prothorax moderately transverse (♂), more strongly so (♀), sides strongly arcuate, base but little wider than the apex; punctures close in the darker areas, sparser elsewhere; margin very narrowly and imperfectly smooth. Elytra parallel, about ½ longer than wide, punctures confused in a rather long baso-sutural area which extends to behind the shield; striae elsewhere nearly regular, except for the interruption or break in the fifth and sixth at about the middle; marginal interspace impunctate. Pygidium blackish brown with oblique yellow spots confluent at apex. Body beneath piceous, with apex of last ventral and small spots at sides of the segments, pale. Legs yellow, with femoral and tibial rings of darker shade, more pronounced in the female. Anterior claws of male a little enlarged. Length 2.5-3.1 mm.; width 1-4-1.75 mm.

Type: Male, No. 2432, Mus. Calif. Acad. Sci., collected by E. P. Van Duzee, April 8, 1921, at Guaymas, Sonora. Allo-type, No. 2433, Mus. Calif. Acad. Sci., collected by E. P. Van Duzee, April 19, 1921, on San Esteban Island. Paratype, one male collected at Guaymas, April 9, 1921.

Closely allied to P. alacris Fall, but distinct by the more strongly rounded sides of the thorax, which is also less narrowed in front.
21. **Pachybrachys peninsularis** Fall

Guaymas, Sonora, April 11; one example. The single example being a female, and the only previously known specimens being males, the identity cannot positively be asserted, although the general characters are fairly in accord. Exception should be made of the tenth antennal joint, which in *peninsularis* is five times, and here only three times as long as wide; quite possibly a sexual difference. The size—4.5 mm.—is also considerably larger than that given for the known males (3.3-3.75 mm.).

22. **Pachybrachys nubilus** Bowditch

San Francisquito Bay, Lower California, May 10; Agua Verde, Lower California, May 26; San Marcos Island, June 19. Four examples, all females.

23. **Pachybrachys sp.**

Ceralbo Island, June 7; a single male specimen. Very close to the preceding species, differing in the somewhat more narrowly separated eyes, the lack of any trace of elytral spots, and the almost total obliteration of markings on head and thorax. The differences, however, are so small that I am unwilling to found a new species on the unique.

24. **Cryptocephalus sp.**

A single specimen collected at Guaymas, Sonora, April 10. It is closely related to our *leucomelas* and *castaneus*, but I think not referable to either. It is not like any species figured in the Biologia, but I am unable to satisfy myself that it has not been described from Mexico.

25. **Diachus auratus** Fabricius

San Marcos Island, May 12; a single example.
26. Colaspis brunnea Fabricius

Eight examples taken at Mulegé, Lower California, are undoubtedly identical with Arizona specimens in our collections thus identified by Horn. I somewhat doubt the correctness of this determination, but am unwilling at this time to say more because of unfamiliarity with the Mexican species.

27. Metachroma insulare Fall, new species

Moderately elongate, form nearly as in anxicolle but with the elytra relatively a little longer. Head, antennæ and legs rufotestaceous, elytra with a broad black discal area which reaches the base narrowly just within the humeral umbones and along the suture, the margins otherwise dull rufous throughout, and with a short narrow rufous vitta from the base to about the middle on either side of the suture; surface throughout polished and strongly shining. Head distinctly but rather sparsely and finely punctate, vertex with a short longitudinal impressed line, supra-orbital groove not extending upon the front; clypeus more deeply narrowly emarginate than usual. Prothorax not quite 1/3 wider than long, sides strongly evenly rounded, base and apex subequal, front angles slightly auriculate, hind angles very obtuse but defined; surface numerous but not densely punctate, the punctures coarser than on the head, narrowly smoother along the margins. Elytra less than 1/6 wider than the thorax, and twice as long; about 1/4 longer than wide; punctate striate, the two short striae external to the seventh confused; strial punctures rather coarse at base, becoming gradually very fine at apex; intervals nearly flat, extremely sparsely, minutely, irregularly punctulate, the punctures scarcely visible except under high power. Propleura smooth; metasternum with some coarse punctures at sides, the median parts not visible; abdomen sparsely punctate and pubescent. Legs rather stout, hind femora with a very small acute tooth beneath, one-third from the knee. Length 3.9 mm.; width 1.9 mm.

Described from a single specimen, sex unknown.

Type: No. 2434, Mus. Calif. Acad. Sci., collected by E. P. Van Duzee, July 1, 1921, at Pond Island Bay, Angel de la Guarda Island.

This species runs to longulum in Horn's table, and falls naturally between that species and anxicolle. It is a little more elongate than the former and less so than the latter. It differs moreover from anxicolle by the entire lack of metallic lustre, the much less densely punctured head, and the smooth
propleura. From *longulum* it may be separated by the much less coarsely punctured elytral stripe, which are not visibly impressed, and by the punctate metasternum.

28. **Monoxia obtusa** Le Conte

Doubtfully under this name I include a series of 45 specimens from the following localities: San Esteban Island, April 19; Isla Raza, April 21; Isla Partida, April 22 and July 2; Mejia Island, April 30; Angeles Bay, Lower California, May 4-5; San Lorenzo Island, May 9; North San Lorenzo Island, June 24; Iddefonso Island, May 17; San Francisco Island, May 30; Ceralbo Island, June 7. Specimens from Isla Raza bear labels "ex Atriplex."

In the series of specimens before me there is considerable variation in size as well as in the extent of maculation of the elytra. Certain examples, in which the spots are almost or quite wanting, closely resemble typical *obtusus*; others, among those with the small spots well defined would pass readily for *debilis*. Horn, in the latest paper on Monoxia, unites *obtusus* and *debilis*, and whether rightly or wrongly so I am quite unable at present to separate the material at hand into definable species. In fact, after removing the readily recognizable *puncticollis* and *sordida* the remaining aggregate of our described and undescribed Monoxias constitutes an almost unsolvable puzzle so far as the delimitation of species is concerned.

29. **Monoxia sordida** Le Conte

A considerable series of this common species of our southwestern border States was submitted, the following localities being represented. Gonzales Bay, Lower California, April 29; Loreta, Lower California, May 19-20; Agua Verde, Lower California, May 26; San José Island, May 29; Ceralbo Island, June 7; Escondido Bay, Lower California, June 14; Concepcion Bay, Lower California, June 18; nineteen specimens altogether.

30. **Diabrotica balteata** Le Conte

Guaymas, Sonora, April 8-11; three examples.
31. **Diabrotica duodecimpunctata** Fabricius  
Mulegé, Lower California, May 15; one example.

32. **Diabrotica trivitata** Mannerheim  
San Pedro Martir Island, April 18; Angel de la Guarda Island (Pond Island Bay), June 30; sixteen examples.

33. **Scelolyperus flaviceps** Horn.  
San Pedro Bay, near Guaymas, Sonora, July 7; one specimen.  
This agrees nearly with specimens from Arizona, but the under surface is more or less pale, mixed with piceous (possibly immature), and the punctures of the elytra are a little stronger and less fine.

**Blepharonycha** Fall, new genus  
Form broadly oval, somewhat oblong, convex, glabrous. Head moderate; eyes obliquely vertical, separated above by a little more than their own length; front nearly vertical, tubercles feeble, flat, narrowly separated; clypeus truncate; labrum transverse, arcuate in front; palpi slender, nearly as in Blepharida. Antenne fully 4/5 as long as the body, basal joint arcuate clavate, nearly as long as the next two; second short, as wide as long; third twice as long as the second, cylindrical with the apex a little expanded, rather more than twice as long as wide; fourth and fifth equal to the third, following joints gradually shorter, the tenth about ½ longer than wide; eleventh longer and pointed at apex, the narrowed apical portion simulating a small twelfth joint, but apparently not movable. Thorax strongly transverse; base evenly arcuate, finely margined; no trace of antebasal groove or impression; front angles prominent as in Blepharida. Elytra oblong oval, widest at middle, closely punctate, the punctures irregularly serial in arrangement. Prosterum rather widely separating the coxae, coxal cavities open behind. Mesosternum oblique in front, intercoxal process as wide as that of the prosternum. Ventral sutures fine, the first and last segments more elongate. Legs rather stout, posterior femora moderately inflated, tibiae gradually broader to apex, each with a short terminal spur; middle and hind tibiae obliquely truncate posteriorly at apex, the truncate area distinctly grooved, and limited above by a well marked angulation; tarsi stout, first two joints triangular, the last slender with bifid claws.

The structure of the tibiae and tarsi is essentially the same as in Blepharida, with which this interesting species agrees.
nearly in some other characters. In fact it answers so well in size, form and color the description of *Blepharida atripennis* Horn from the same geographical region that it seemed almost certain at first sight that this was the species in hand. On closer examination however the front coxal cavities were found to be open behind rather than closed as in Blepharida, the mesosternum is oblique in front (vertical in Blepharida) and the second antennal joint is relatively much shorter, comparison in these respects being made with *B. rhois*. To make sure that the insect in hand was not *B. atripennis*, it was returned to the California Academy for comparison with Horn's type. Mr. J. O. Martin, who kindly made the comparison, assures me that the coxal cavities are close in *atripennis*, and that several other differences are obvious when the two insects are placed side by side.

The open coxal cavities of course exclude the present species from Blepharida, and the bifid claws exclude it from every other Halticide genus of our own fauna. Certain Mexican Halticine genera have the claws bifid, but none of them, judging from the figures in the Biologia have a facies at all similar to the insect in hand, except perhaps Plectrotreta, in which the hind tibiae alone are said to be armed with a terminal spur, and the pronotum has an antebasal groove.

Reference to Chapuis' table of groups (Lacordaire, Genera, XI, p. 20) shows that our species runs to his Diamphidiitès, in which he includes the single genus Diamphidia, all the known species of which are from South Africa. These, according to the group characters used by Chapuis, have the antennae either flabellate or serrate, and are said to be aberrant forms, intermediate between Galerucides and Halticidés. There seems therefore to be no other course than to erect a new genus for our present species, which after the generic diagnosis given above needs only a brief description.

Type. *Blepharonycha melanoptera* Fall.

34. **Blepharonycha melanoptera** Fall, new species

Form robust, oblong oval; head, prothorax, scutellum and femora, yellow; antennæ black, the basal joint yellow with a black stripe above; elytra, tibiae and tarsi black. Head shining, with a few minute punctures; prothorax twice as wide as long, base and apex nearly equal, sides evenly
rather strongly rounded, hind angles very obtuse, front angles dentiform with a small sinuation externally; surface smooth and polished, with a few very small and remote punctures; disk with a punctiform impression each side of the middle at about the lateral fourth, which may or may not be normal.

Elytra a little wider than the thorax, 3/10 longer than wide, sides broadly arcuate, apex obtusely rounded; surface finely alutaceous, scarcely shining, closely punctate in approximate more or less irregular rows. Prothorax beneath smooth; metasternum smooth at sides, coarsely punctate at middle; ventral segments nearly smooth, shining, finely sparsely pubescent. Legs stout, hind thighs not quite half as wide as long. Length 5.8 mm.; width 3.4 mm.

Described from a single example, sex unknown, taken at San Carlos Bay, Sonora, July 9, 1921.

Type: No. 2435, Mus. Calif. Acad. Sci., collected by E. P. Van Duzee, July 9, 1921, at San Carlos Bay, near Guaymas, Sonora.

35. **Haltica nitidiventris** Fall

Esperitu Santo Island, June 9; one specimen. Except for its somewhat larger size, this agrees in all essentials with the unique type specimen in my collection, which was described from El Taste in the nearby Cape Region of Baja California.

36. **Systena tæniata** Say. var.

Mulegé, Lower California, May 15; five examples. This is one of the numerous forms so common in our southwestern border States, all of which were considered by Horn as variants of *tæniata* Say. The form before me is entirely pallid except for a faint darker sutural stripe, is sparsely lightly punctate, and shining throughout as if varnished. I have a series of similar specimens ranging from El Paso, Texas, to Kern Co., California. None of the names thrown into synonymy by Horn apply well to this form.

37. **Longitarsus livens** Le Conte

Las Animas Bay, Lower California, May 8; Mulegé, Lower California, May 15; Loreto, Lower California, May 20; sixteen specimens.
38. **Glyptina cerina** Le Conte

Angel de la Guarda Island (Palm Cañon) May 3; San Carlos Bay, (near Guaymas) Sonora, July 9; two examples.

39. **Phyllotreta albionica** Le Conte

La Paz, Lower California, June 3; two examples.

40. **Charistena ariadne** Newman

Mulegé, Lower California, May 15; one example. This species was recorded from the Cape region (San José del Cabo) by Horn in his paper on the Coleoptera of Baja California in 1894. The single example before me differs a little from eastern specimens in my collection by the more sparsely punctate thorax and less elevated elytral costae, but is probably specifically the same.

41. **Brachycoryna pumila** Boheman

Guaymas, Sonora, April 11; one example.

42. **Stenopodius flavidus** Horn.

San Francisco Island, May 30; five examples.

43. **Gratiana pallidula** Boheman

San Esteban Island, April 19; one example.

**Errata for Proceedings, Vol. XVI, No. 13.**

Page 382, line 12, for Lac. read Lee.
Page 385, line 17, for sense read sense.
Page 386, line 25, for mimnonius read memnonius.
Page 386, change line 28 to read Guaymas, April 10, and San Pedro Bay, July 7, Sonora; two examples.
Page 392, line 3, for trivittata read trivittata.
Page 393, line 13, for coxae read coxal, and for close read closed.
A STUDY OF THE TERMINAL ABDOMINAL STRUCTURES OF MALE DIPTERA (TWO-WINGED FLIES)

BY

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This paper was written as a part of the requirements for the degree of doctor of philosophy at Stanford University, and I wish to express my thanks to Professors R. W. Doane and G. F. Ferris of the Department of Entomology in that University for their helpful suggestions and aid in many ways during the progress of the investigations. The original manuscript and the drawings were sent to Dr. G. C. Crampton of Massachusetts Agricultural College, and I am greatly indebted to him for reading over the manuscript and suggesting many important changes. In the original manuscript I had followed Berleze and Metcalf in numbering the abdominal segments (allowing for a hypothetical first segment fused with the thorax) but I am now converted to the view held by Dr. Crampton. The genitalia are therefore considered to be on the ninth abdominal segment, any fusion of segments occurring at the apex of the abdomen.

I am indebted to the following entomologists for material loaned: Dr. C. P. Alexander, Massachusetts Agricultural College; Mr. C. W. Johnson, Boston Society of Natural His-
tory; Mr. E. P. Van Duzee, California Academy of Sciences, and Dr. J. M. Aldrich of the U. S. National Museum. Most of the material used was from the Stanford University collection and from the writer's collection.

Manuscript notes and drawing of the hypopygia of the Muscidæ (sens. lat.) were prepared some years ago by R. E. Snodgrass while at Stanford University, and these were of assistance in comparing results of dissections. Any study of this kind has of necessity to borrow more or less from the results of previous workers, and the papers by Lowne, Snodgrass, Wesche, Newstead, Metcalf, Crampton, and others, have paved the way for this contribution to the study of the genitalia of male diptera.

In studying a series of insects ranging from primitive to specialized types it is often very difficult to homologize the parts of the genitalia; it may require in some cases a study of the organs in the early stages of the insect, and there is much work yet to be done in this field. There is danger in drawing conclusions from a small amount of material; a series of generalized and specialized types should be studied where possible, but in a paper such as this space forbids the description of more than a few representative species for each family. The fine work recently done by Crampton in this field demonstrates clearly that the basic plan of the male genitalia of the Diptera can be established, and a generalized type arrived at which can be homologized with the orders of insects that are closely related. Some of the secondary structures may be difficult to homologize.

The systematist in present-day entomology has to deal with very minute differences of structure in the characterization of species. Some of the most remarkable characters are to be found in the structures that go to make up the male genitalia, and as a rule these characters are the most dependable of all. In studying other parts of the body we often find a great deal of individual variation, as in the body color, shape of markings or color of the pile, but the male genitalia are remarkably constant for the species and the student of Diptera will find it well worth while to study these organs in any group with which he is working.

We cannot, of course, have a system of classification based
on the male genitalia alone, or on the female reproductive system alone, because a natural classification will not admit of the adoption of one set of characters to the exclusion of others. The greatest value of genitalic characters will be in the characterization of species, but there may be structures common to genera or even larger groups.

Time did not permit of biological investigations in connection with this study. The paper is intended primarily as an aid to the worker in taxonomy, but there are many interesting problems suggested for the insect morphologist. All of the principal families of Diptera were studied and more than 250 species dissected.

Charles Darwin in a letter to B. D. Walsh in October, 1864, wrote the following: "What can be the meaning or use of the great diversity of the external generative organs in your cases in Bombus and the phytophagous coleoptera? What can there be in the act of copulation necessitating such complex and diversified apparatus?" The same could be said of most male Diptera. The meaning or use may not be clear to us, but it probably has an important bearing on the evolution or the stability of the species.

Methods

The writer has had good results with very simple methods in preparing the genitalia for study and very few fresh specimens were used, most material being pinned and dried. Specimens were prepared by breaking off the abdomen, or the genital portion, and boiling in 10 per cent KOH for from ten to thirty minutes, depending upon the degree of chitinization; in a few cases it was necessary to soak the material in KOH for a few hours. After this the material was washed in distilled water and placed in 70 per cent alcohol until studied. Most specimens were of such size that dissecting could be done under a binocular microscope. The writer prefers to draw without the aid of a camera lucida.

The Male Genitalia

The most recent work in this field is that by Metcalf on the male genitalia of the Syrphidae and Crampton on the male genitalia of Mecoptera and Diptera. Metcalf studied all of
the important syrphid genera in North America and about
200 species, so that his conclusions are of considerable im-
portance in a study of the Diptera as a whole; he made no
attempt to homologize the parts of the genitalia with those
described in other orders of insects, giving, in large part,
such names as were appropriate to the parts and in addition
to these terms certain others that were devised for convenience
in description. The work of Crampton is much broader in
its scope and deals with many of the genitalic structures from
the standpoint of phylogeny.

There has been considerable theorizing as to the number
of abdominal segments and most authors have given ten as the
number in higher insects. The presence and position of the
spiracles is of importance in determining the actual segments
represented. Most embryologists hold that there are twelve
segments in the primitive forms and the Protura in certain
cases retain the twelve segments. Crampton finds that the
retention of even eleven segments is not common in the lower
winged insects. Certain embryologists have apparently estab-
lished the fact that the cerci are modified limbs of the eleventh
segment, and if this is true there are two segments beyond
the genitalia proper. I have finally come to the conclusion
that the first visible segment is actually the first and that
there is no fusion of a hypothetical first segment with the
thorax, a theory held by Berlese and Metcalf. If any fusion
has taken place it is in the tenth and eleventh segments. There
are never more than eight pairs of spiracles on the abdomen
and usually only seven pairs, so that the apical segments are
sometimes hard to distinguish. Berlese calls the first visible
segment the actual third, but this is certainly a mistaken view,
as is his supposition that the apparent sixth segment is a
"large basal expansion of the seventh."

Metcalf uses two convenient terms in dealing with the Syr-
phidæ, namely, preabdomen and postabdomen. These terms
are useful where the posterior segments of the abdomen are
modified, but there are only a few families where the divisions
of the abdomen are so distinct as in the Syrphidæ. The pre-
abdomen may be reduced to three segments, or the apical
modification of the segments may be confined to the last three,
the postabdomen being adapted to the form and function of
the genital appendages. The anus bearing segments are involved in the revolution of the genitalia of Diptera, and in this respect they differ from the male sawflies. The torsion of the terminal abdominal segments is found in certain tipulids and culicids and also in a few mycetophilids. This revolution of the last three segments is quite different from the remarkable twisting of the postabdomen found in the Syrphidae and Pipunculidae. These last two families have the basal segments of the abdomen crowded over to the left side of the preabdomen; the rotation is clockwise along the long axis, and in many species of these two families the terminal tergites and sternites have gaped apart.

There is often a depression in the preabdomen caused by the folding of the postabdomen against it; this depression is partly or wholly membraneous owing to the pressure on the hypodermal cells; it is called the **genital pouch** by Metcalf and is greatly developed in the Syrphidae. Owing to the torsion and pressing together of segments in the genital region there has been considerable misinterpretation of the postabdomen; tergites are apt to be mistaken for sternites and vice versa. The term **hypandrium** for the plate or sternite below the genitalia is a useful term proposed by Crampton; the term **epandrium** is used for the plate above the genitalia. The word **hypopygium** is used to designate the entire male genitalia and is therefore confined in its strict interpretation to the ninth abdominal segment.

The eighth urite in many forms is a single sclerite and as there are no spiracles on this segment there is often some question as to its being a sternite or tergite, but it is probably the latter. The modified appendages and limbs of the ninth abdominal segment make up the male genitalia and none of these parts are a part of the tenth segment. It is probable that there are eleven segments in the abdomen, in which case the anal region, or **proctiger** of Crampton, consists of the fused tenth and eleventh segments.

The ninth urite becomes specialized and greatly developed in many families of the Diptera and carries the **styles**. The shape of the ninth tergite is modified by the shape of the cerci on the distal margin in many species; the ninth sternite in many forms serves as a lever between the styles and the
base of the aedeagus. The genital opening is said to be primitively between the ninth and tenth sternites. The cerci make up most of the proctiger and there are indications of paraspodial plates at the base of the cerci in some of the families; in fact the organs called the cerci may in reality be paraspodial plates in some forms, as has been suggested by Crampston. The plates on either side of the anus will in this paper be considered the cerci; this point could possibly be made clear by embryological investigations. The surface of the cerci is usually hairy, the hairs being probably sensory in many cases. The plate above the anus, or supraanal plate, may be termed the epiproct; as used in this paper the term refers to the terminal abdominal tergite. The cerci are the appendages IV of Newell and the forceps superiores of Wesche. They are usually quite simple and do not vary greatly.

The intromittant organ of the male is centrally located and is easily homologized in the families of the Diptera; the true penis is membranous and largely internal, or with a sheath, and the organ often referred to as the penis is best termed the aedeagus, a term used by the students of several orders of insects. Several investigators have found that the true penis is often exserted by blood pressure; the sheath, or aedeagus, guides the penis and is nearly always rigid. There are a few cases in the Diptera where the true penis seems to be without any covering. The aedeagus in some species is armed near the tip with cornuti, or more or less complex appendages. In some insects there is a false penis which is used to open the vagina before the true penis is exserted; an arrangement of this kind is probably present in some of the Diptera.

Sharp and Muir termed their work on the Coleoptera as a study of the "male genital tube," and these authors maintained that a complete understanding of the male structures was possible only when the female organs were studied in connection, the two taken together forming the "genital conduit."

The orifice of the genital tube arises from the invagination of the tube itself, so that it is a doubled tube, one end a continuation of the body wall and the other branching to
the two testes; there may be a chitinization of some parts of the wall. The tube is a ventral structure and has no tergal plates, but sternites may enter into the making of it. The aedeagus may be produced into a long flagellum, it being coiled into the apical segments of the abdomen in some of these forms. In some of the Coleoptera and Mecoptera this kind of structure is to be found. In some of the Diptera there are two or even three openings of the ejaculatory duct. In a few primitive orders of insects the penis is represented by structures that are in some cases difficult to homologize; in the Ephemeridæ and in the sawflies this organ is represented by paired valves or "penis valves" as they are termed by Crampton. The aedeagus is generally considered the fused appendages of the ninth segment, arising from the caudo-ventral portion of the segment. The orifice of the ejaculatory duct is often hard to make out and may be on an elevated portion called by Metcalf the ejaculatory process.

In describing the appendages of the aedeagus Lowne used several terms which it may be well to retain as they have been used by several writers since his time, these are: the paraphalli, two strongly chitinized, lateral rods from the back of the part, and the hypophallus, a paired organ arising from the front part of the sheath. One or both of these structures may be present or absent. The "chitinous box," so-called by Metcalf and Berlese, is an expansion near the base of the projecting portion of the aedeagus (Metcalf states that is near the apex of the penis) and rests usually on the apex of the double apodeme. The processes on this structure are given names by Metcalf in his paper on the family Syrphidae. The "ejaculatory hood", a term used by Metcalf, is a modification of the apex of the aedeagus that is unusually well developed in the Syrphidae. This structure is absent in many of the families of Diptera.

The structure called the double apodeme by Wesche and the "sustentacular apodeme" by Metcalf, gives support to the aedeagus, especially to the chitinous box and the muscles which rotate the parts are attached to it. The apodeme is easily seen in many species when cleared; it may be double, partially fused or wholly united, and is often specifically distinct in related forms.
The ejaculatory sac is an expansion of the efferent ejaculatory duct near its proximal end and is often flask-shaped. Delicate muscles extend from this sac to the margins of the ejaculatory apodeme, which varies in form but is in many cases umbrella-shaped. The theory is that the contraction of the muscles pulls the rod-like base of the apodeme into the sac like a piston and expels the seminal fluid, but there are many cases where this action must be quite different owing to the shape of the apodeme or its small size. The form of the ejaculatory apodeme may be of considerable taxonomic importance.

The aedeagus is often heavily chitinized and is usually more or less cylindrical, being as a rule much longer than broad, but in some groups it is very short; in many groups the aedeagus is greatly specialized, possessing keels, ridges, tubercles, etc. Wesche divides the sheath of the penis into “two canals (epiphallus and hypophallus)”, considering them contributions from the eighth and ninth segments; in this he is certainly in error, any apparent division being due to difference in chitini-

[Continuation...]

I have adopted many of the names used by Lowne and Wesche in considering these structures at the base of the aedeagus, many of which are absent in whole families of the Diptera. The base of the aedeagus in the Diptera is apparently the same as the “tegmen” of the Coleoptera, a name given by Sharp and Muir, and consists of a basal piece or ring and the appendages. Of these appendages there are, as a rule, two in the Coleoptera (lateral lobes), and usually two pairs in the Lepidoptera. These appendages may be known under the general name of “gonopods.” The term “harpes” is preferable for the terminal segments of the gonopods of insects in general, but there may be some confusion if it is adopted because of other uses of the name. The terms basistylus and dististylus, proposed by Crampton for the two segments of the genital styles, will be used in this paper. In the Diptera and other higher insects a pair of styles forms the outer ventral pair of claspers on each side of the aedeagus. The lateral portions of the ninth segment may be prolonged...
and form accessory clasping organs, which may be known as surstyli. The dististyli and surstyli often have spines or ridges on the surface to aid in holding the females more securely. The genital styles are the “appendages 1” of Newell, the “claws” of Lundbeck, the “forceps inferiores” of Wesche, and correspond to the “valvulae externae” of Lowne. They are commonly known as the “claspers” and vary greatly in size and shape; there is often an accessory lobe of the dististyli (occurring also in some Panorpids) and in some the dististyli is divided into an inner and outer lobe.

The laminae superiores, so named by Dziedzicki, are paired processes, often on a separate plate on the anterior edge of the cavity containing the genitalia; they are strongly chitinized in some species and often armed with bristles. They probably aid in holding the female and are absent in most of the Diptera.

The term interior forceps may be used for the “forceps inferiores” of Wesche. These are small, usually blade-like processes on either side of the ædeagus, generally articulated and more or less chitinized, the surfaces usually smooth. These organs were called the “posterior gonapophyses” by Lowne and later Snodgrass used this term, pointing out at the same time that the name “gonapophyses” was likely a misnomer from the standpoint of homology. The so-called genital palpi are small palpiform organs, one on either side of the ædeagus but anterior to the interior forceps; they usually possess sensory hairs or setae. The term “palpi” was used by Wesche and is not a good one because of the generally accepted use of the term in referring to the palpi of the mouth parts. Wesche, of course, was attempting to show the close correspondence of the mouth parts to the genital structures. These organs were called “anterior gonapophyses” by Lowne. When they are absent there may be compensating sense organs in this region. Metcalf terms the two pairs of organs described above the “internal lobes”, referring to them as cephalic or caudal internal lobes.

The so-called spinus titillatorius is a single unpaired organ and is not found in many of the families of Diptera; it arises from the base of the ædeagus without any suture and has a
tendency to being membranous at the tip. Lowne termed the organ the "spine." It is well developed in some species of the genus *Dolichopus*.

**Asymmetry**

There are some remarkable cases of asymmetry in the genitalia of the Diptera, but no examples are known among the more primitive forms; beginning with the family Cyrtidae we find many instances of distinct asymmetry through the various families. The Syrphidae and Pipunculidae nearly always have the postabdomen quite asymmetrically developed, and there are other families in which this is the general rule. The uneven development is usually cephalad of the ninth segment, but there are instances where the appendages of the ninth segment are not the same on the two sides; in these cases it is nearly always the left side or left appendage which is shortened. In the Syrphid genus *Sphegina* all of the parts of the genitalia are asymmetrical. The pressure of some part of the genitalia against the sternites adjacent to them apparently stops chitinization in many species, so that the ventral part of the postabdomen is often largely membranous. A study of the pupal stage should be made in this connection, in order to see where this asymmetry first takes place and just what causes it.

**Functions**

The object of the male genital tube is to introduce the seminal fluid into the uterus of the female, and, as Sharp and Muir point out, the male and female genitalia form functionally a single organ—the genital conduit. It is probable that the sperm is always placed directly in the spermatheca, but there are species so constructed that it is difficult to see just how this is done. In cases where there is a very long female ovipositor there is a correspondingly long ãedeagus in the male, as in the Ortalididae and Trypetidae. The evagination of the penis is by means of blood pressure, the invagination by means of muscle contraction in certain areas. The spines and hairs on the ãedeagus, when present, point basally, thus serving to keep the organ in the uterus of the female. There must be great pressure in order to send the seminal fluid through the
penis when this organ is remarkably long and the duct of small diameter, and a great amount of muscular force is necessary to control the organ. The female undoubtedly plays a more or less active part in copulation in many species.

Certain of the organs are of use in holding the female during copulation; the styles are among the most important of these and they often have spines and hairs on their surfaces which aid in the holding; in some cases there are claw-like appendages. There may be processes, bristles, etc. on the fourth and fifth sternites which aid in holding, or there may be modifications of these segments into claspers, as in some of the Scatophagidæ and Micropezidæ. Various parts of the aedeagus are also modified so as to hold the female.

Metcalf states that the only organs that appear to have a sensory function are the cerci. These organs are almost always exposed and often have on their surfaces sensory pits or hairs. It is quite possible that the genital palpi also have certain sensory functions.

**Taxonomy and Phylogeny**

Coleopterists have found the male genitalia to be of great importance in taxonomy, especially in the separation of species, and Sharp and Muir have shown their importance in arranging large groups of species. In the Hemiptera the genitalia may be of generic value and in the Odonata they have been used in the defining of tribes and subfamilies. We find in the Diptera that there are types of genitalia characteristic of whole families, even though there are at the same time great specific differences. In certain groups Nature seems to have “run amuck” in the matter of specialization of the genitalia, just as it has done in the specialization of wing venation in some groups. The Tipulidæ are primitive in most respects and yet the genitalia are remarkably complex in many of the genera. The female genitalia have been given considerable weight in the erection of genera and even families in the Muscoid flies, but it is doubtful if the male genitalia will always show structures that will fit into this classification.

The chitinization of certain areas gives very good characters for the differentiation of species, and the limits of these areas are usually quite constant. Creases and pressure in certain
areas may prevent the development of the hypodermal cells and limit their extension. The genital tube is long in some forms and in such cases there would be a tendency for it to fold and form separate sclerites along its length.

There may be some objection to taxonomic work which requires more or less preparation of the specimen or even dissection, but the mere fact that more work is required is not always a primary consideration. It is a pleasure to be able to determine species with the aid of a low power lens or without the aid of a lens, and fortunately there are many species which will not under ordinary circumstances require closer work, but the day is coming when “new species” in the Diptera will be founded on some structural character, and, when other parts of the body are not sufficiently characteristic of the species to preclude confusion with related forms, the genitalia of the males will in most cases decide the point. Many species described in the past have been separated by differences of color and vesture; in these cases the naming of poorly preserved specimens is an almost hopeless task, yet a study of the male genitalia may reveal remarkable differences, and these organs are seldom injured in preserved specimens. When the male genitalia of certain forms are carefully worked out by one student, then others may profit by this work and in many instances no dissection is necessary, enough of the structures being visible to make the determination certain. In describing the genitalia many structures can be best described by figures; it is often difficult to describe some of the complex parts in words.

**Phylogeny**

The student is referred to recent papers by Crampton for detailed information on this subject. In the lower Diptera, such as the Tipulidae, the relation of the parts of the genitalia is the same as in the sawflies (Hymenoptera of the family Tenthredinidae), certain of the structures being developed secondarily so that the general appearance is often quite complex, but the basic plan is the same. Crampton is undoubtedly correct in his conclusion that the Diptera are very closely related to the Mecoptera; this relation is clearly seen in a study
of the male genitalia, and the relation is borne out in a study of the mouth parts and other organs. According to recent studies the Mecoptera are probably the nearest living representatives of types ancestral to the Diptera, and possibly both orders are derived from Neuroptera-like ancestors, although the genitalia of Neuroptera are dissimilar from the parts of other insects in many ways.

**Morphology**

A study of the anatomy of the male genitalia

**Family Tanyderidæ**

Dr. C. P. Alexander in studying this family has arrived at the conclusion that its known representatives are the most primitive of the recent crane flies, and judging from my own limited study of this interesting little group this seems to be true. Through the kindness of Dr. Alexander I was able to study two forms, *Tanyderus forcipatus* O. S. from New Zealand, and the rare *Bruchomyia argentina* Alexander from Argentina.

The genitalia of *T. forcipatus* are shown in fig. 1. The âedeagus is divided into three forks at the apex, apparently the middle one being the opening of the ejaculatory duct. Two ridges at the base of the basistyli (so-called side pieces) take the place of the guards of the âedeagus. The cerci are greatly reduced.

From a study of the male genitalia (as well as some other characters) the writer agrees with Alexander in placing *Bruchomyia argentina* with the Tanyderidæ rather than considering it a primitive form in the Psychodidæ, as some authors have suggested. The genitalia do not suggest the Psychodidæ, and for that matter are quite different from the genitalia of *Tanyderus*, as can be seen from figures 2 and 3. The âedeagus is normally almost entirely internal and there are no indications of the interior forceps or genital palpi. Probably a new family will be required for the reception of this unusual species.
Family Tipulidae

The male hypopygium in this family has been used considerably by taxonomists as a source of characters important in the classification of species; the structures can be homologized through the group although there are some unusual specializations. The generalized forms in many genera have a simple hypopygium and there are rarely any modifications of the segments cephalad of the eighth segment; in some species the ninth segment is greatly specialized and the structures quite complex. The genitalia of several genera were worked out by Snodgrass, whose interpretation has been followed by Alexander and others in many taxonomic papers.

In the Tipulinae the so-called “pleurites” are closely attached to the sternites and have various appendages. Crampton called the writer’s attention to the fact that the “pleurites” of Snodgrass are in reality the basistyli. The ninth tergite is variable in shape and may be large or small, with the caudal margin straight or variously modified. In some forms the appendages of the basistyli project through the median notch of the ninth tergite when at rest; in certain species a median lobe may be developed. The ninth sternite is also of various shapes and sizes and in some forms is separated from the basistyli by a distinct suture. As noted by Alexander, the “pleural” suture is often short and may be only a short impression on the ventral side of the basistyli. In some species, as in Tipula derbyi Doane, the eighth sternite is large and the ninth sets into it. The eighth sternite is usually notched and in some species is apparently divided by a median line. In the lower genera the basistyli are in their normal position, but in some forms they are pushed to the outer side of the sternite or are absent. The terms proposed by Westhoff for these structures seem unnecessarily cumbersome. There are many modifications of the basistyli, usually with two appendages, the outer one often more or less fleshy, the inner, or secondary appendages, usually heavily chitinized. The latter I interpret as the dististyli. Crampton figures these as the apical and subapical appendages.

The interior forceps and guards of the ædeagus vary a great deal in different species. In the lower genera the ædeagus usually projects backward as a slender rod, in the Tipulidae being carried up anteriorly and on the dorsal wall of the geni-
tal chamber, then down the anterior wall and posteriorly along the floor of the genital chamber. The ejaculatory sac is usually quite conspicuous as a basal swelling. The true penis is inside the long rod and in some species is half the length of the abdomen when stretched out. In all groups the ædeagus has a guard, usually two long plates, the lower edges being united by a membrane; there are many modifications of this form. In most forms the interior forceps and the genital palpi (gonapophyses) can be made out. The sheath of the penis may have been originally a pair of processes projecting caudally above the penis and another pair below.

In the Limnobiinæ the basistyli are prominent and have appendages of considerable size which act as claspers. In Geronomyia and others the apical appendages of the dististyli are soft and fleshy, the subapical appendages in the form of sharp hooks (fig. 12). The genitalia in Gonomyia are very complex and hard to homologize (fig. 13). In Acyphona and some other genera the hypopygium is asymmetrical and there is more or less torsion, the ninth segment being twisted half way around (as in some of the Culicidæ). In Chionea, Cladura and Pterochionea there is a single powerful pleural appendage on each side, the basistylius. The penis guards on the venter of the genital chamber are quite prominent in some forms.

The cerci are usually large hairy plates and are quite varied in shape, one on each side of the anal opening. There is usually a double apodeme at the base of the ædeagus; in Nephrotoma two pieces represent the atrophying apodemes. According to Alexander, the genus Macromastix, with more than 50 species from Australia and New Zealand, shows considerable torsion of the genital segments.

**Family Ptychopteridæ**

Three species were studied in this family, Bittacomorpha clavipes (Fabr.), Bittacomorphella sackeni (Röder), and Ptychoptera lenis O. S. The basistyli are well developed in all of these forms and have apical appendages. The surstyli are unusually developed.

The abdomen in the first two genera is exceptionally long and slender. The ninth tergite has a tendency to divide and the cerci are not well developed. Below the ædeagus there is
a peculiar structure which resembles the anal segment in some other forms; this structure serves as a guard for the ædeagus. The interior forceps in Bittacomorpha are chitinized and peculiar in shape, the gonapophyses rounded and more fleshy (fig. 14). In the genus Ptychoptera the guard below the ædeagus is larger and forms a half sheath.

**Family Rhyphidæ**

According to Wesche the cerci (which he calls forceps superiores) are complicated and strongly chitinized in Rhyphus fenestralis Scopoli, hairy and smaller than the same structures in R. punctatus Fabr. In the latter species the ejaculatory duct at the inner end presents the appearance of a long tangled thread (figs. 16 and 18). A specimen of R. alternatus Say was loaned from the National Museum collection. The thread of the ejaculatory duct is much longer than in R. punctatus, there being eleven coils at the end when stretched out as shown in fig. 16. The ædeagus and apodemes are heavier than in punctatus; the styles are short, heavy and claw-like. The cerci are comparatively large and densely pilose.

A male of Mycetobia divergens Walker was loaned by the National Museum. Some of the genital structures were accidentally broken in dissecting and a structure which I take to be the long ejaculatory duct has become separated from the basal attachment; it is not shown in fig. 34. This is an added proof of the correct placing of Mycetobia in the Rhyphidæ, as the long, coiled tube is not found in any other group so far dissected.

A male of Obliogaster tanitatus Bellardi was loaned by the National Museum. The genitalia are comparatively large, the cerci especially so (shaped much as in Mycetobia divergens). The genitalia are more complex than in other species of the family studied. The basistyli and dististyli are short, heavily chitinized, with an apical long spine curved at the tip; this hook-like spine is on the inner side; a blade-like process projects at right angles to it. There are two pairs of inner appendages, apparently tergal and attached to the base of the cerci, one pair long and blade-like, the other short and blunt, with apical pile. The sternite of the ninth segment has a large median structure which might be mistaken for the ædeagus,
but the true ædeagus is probably at the base of this structure. The ejaculatory duct is not long and coiled at the apex.

The genus Trichocera is now placed in this family, partly because of the great similarity of the early stages; the male genitalia are quite different. In the Trichocera species figured the interior forceps are slender and spine-like (fig. 15); the ædeagus is short and there is no great development of the ejaculatory duct. In another western species of Trichocera dissected the genital styles are simpler, the ædeagus, interior forceps and cerci about the same as in the figured species. The Trichocerinae are the most generalized of the Rhyphidæ.

Family Dixidæ

This is a small family, with one genus, Dixa. The genitalia of one undetermined species of Dixa were studied and found to be tipulid-like in general form, as can be seen from figures 20 and 21. The basistyli are not developed as in some of the Tipulidæ. A male of Dixa fusca Loew was studied and the ædeagus found to be very short, probably extended by blood pressure. The basistyli are heavy, as in the Chironomidæ, with two inner appendages on each, which have bristles on the edges, much like those shown in fig. 26. The cerci cannot be made out with certainty with the binocular microscope; there is a small dorsal structure on each side of the usual location of the cerci. The apodemes are not visible in prepared specimens and are probably delicate and weakly chitinized.

Family Psychodidæ

The male genitalia of the genus Phlebotomus have been worked out in detail by Mr. R. Newstead (Bull. Ent. Research, London, vol. 2, p. 61), and very good specific characters have been found in the study of these structures. In some forms there is no distinct line between the ninth tergite and sternite. The tergal portion is deeply bifid and usually with more or less elaborate appendages, called by Newstead the "superior claspers", which are probably the surstyli; these structures are generally hairy and in some species possess scales. The sternal part is composed largely of processes termed "inferior claspers" by Newstead (probably gonostyli);
between these is a pair of slender appendages, more or less developed. Near the base of the styles are structures which correspond to the interior forceps. The ædeagus in *Phlebotomus* is bifid from the ejaculatory sac to the tip; there are two ducts and the penis is therefore double, its sheath also for some distance.

The genus *Trichomyia* resembles *Phlebotomus* in the genitalia characters (fig. 22). The other two forms studied, *Psychoda* sp. and *Pericoma californica* Kincaid, are much simpler and do not show the double ædeagus and the interior forceps (figs. 23, 24 and 25).

**Family Orphnephilidæ**

In Aldrich's Catalogue this family is placed between the Rhyphidæ and Stratiomyiidæ; it may be related to the former through the genus *Trichocera*, but the Rhyphidæ are now placed near the Tipulidæ. The one species examined, *Orphnephilus testaceus* (Ruthe), has the general appearance of some of the Chironomidæ and the male genitalia show this relation.

The eighth segment is greatly reduced but symmetrical, the ninth tergite with a small median keel as in some of the Chironomidæ. There is a median structure which resembles a double ædeagus (fig. 33), consisting of two slender rods curved over at the apical third. The true penis is probably membranous and is exserted from between these two structures. The ninth sternite is bifid to the base and with an apical claw-like appendage on each side. The cerci are small, only slightly chitinized and concealed beneath the ninth tergite.

**Family Chironomidæ**

The male genitalia of the Chironomidæ have been studied to some extent and have been figured by Malloch, Johannsen and others in this country. The main claspers are on the basistyli. The tergite is often in the form of a keel. The dististyli are the "claspers" and possess good specific characters. The cerci are not well developed.

In *Tanypus venustus* Coquillett the hypopygium is quite simple, being reduced to two large "side-pieces", which I
interpret as the basistyli; the ninth tergite is greatly reduced (fig. 27). In the genus *Chironomus* two species were studied, one illustrated in fig. 26; the genitalia are more complex than in *Tanypus*; the cerci are greatly reduced and not visible from above. The other species of *Chironomus* studied is practically the same as the species illustrated. In *Paraclunio alaskensis* Coquillett the genitalia are very simple.

**Family Culicidæ**

The importance of the male genitalia in this family has long been emphasized by students working on the taxonomy, and as they were among the first workers in Diptera to use these structures a number of names had to be proposed for the purpose of description. Many of these names are not used in other groups of the Diptera, but the names are given here and future work in this field will make clear the homologies. A recent paper on "terminalia" of male mosquitoes by Freeborn (see Bibliography) marks a great advance in this study. There is a great specialization in the genitalia and some of the structures are difficult to homologize. The hypopygium has characters very important in classification and some of the larger groups have structures in common.

The so-called "side-pieces" are undoubtedly the basistyli, the clasping appendages on the apices of these the dististyli; these clasping appendages vary greatly and are quite intricate in some of the Sabethinae. The eighth sternite is usually represented by a pair of small plates, often termed "basal appendages". In the simplest forms of the family there are three pairs of structures on the ninth segment, usually called by students of the family the *unci*, *harpagones* and *harpes*. This use of the term harpes is not the best. In the simplest forms the small "basal appendages", the "harpes" and "harpagones" may be absent (as in *Anopheles*) but the "unci" are always present. The harpagones may be divided, the first division having a supplementary division in *Culex pipiens* (fig. 30). The so-called harpes (different structures here than in other orders of insects) often have a crown of spines and in many forms have finger-like projections. Edwards, in discussing the genus *Culex*, suggests that perhaps after use the parts may assume a different relative position, the unci
folded outwards and the harpagones pushed out so as to be at right angles to the usual position. The above mentioned paper by Freeborn should be consulted for an understanding of the torsion of the terminal segments (including the eighth) through an angle of 180 degrees.

The simplest hypopygium is found in Anopheles and the genus Aedomyia may be regarded as next in simplicity, only the unci being somewhat complex. The genus Uranotænia has no recognizable "harpes", but complex appendages represent the unci. In the genus Sabethes the dististyli are developed in a remarkable manner.

The Corethrinæ may be considered as a subfamily of the Culicidae, although several authors give the group family rank. The male genitalia are simple and show a relation to the Anopheles group. Two species were dissected for study; in one, a species of Corethra, the basistyli are long and with long apical clasps; the unci are present and are strongly chitinized, with a subapical ridge, the other paired structures are not visible or are represented by projections of the surface. The aedeagus is not visible. In the only specimen of Eucorethra underwoodi Underw. available for study the dististyli are broken off, the rest of the hypopygium is shown in fig. 28.

Family Mycetophilidae

There is considerable variation in the hypopygia of these flies. Johannsen has made use of the male genitalia in the classification of the North American species and European workers have made use of genitalic characters for some time. The dististyli are often curiously modified; the aedeagus is usually short and not prominent (figs. 36, 39 and 42); the guards of the aedeagus are often spine-like. The cerci are usually well developed.

The ninth tergite is unusually developed in the species of Symmerus studied (fig. 36). In a few of the difficult genera, such as Exechia, the characters of the male genitalia are the most important in differentiating the species, some of the females being almost indistinguishable. In Boletophila hybrida (figs. 38 and 39) the slender interior forceps recall the structures in some of the Rhyphidæ. The cerci in this species
and in Mycetophila punctata (fig. 42) are very large; the ædeagus in this species and in Tetragoneura pimpla (fig. 40) is very short.

The Sciarinae are here considered as a subfamily of the Mycetophilidae and not as a separate family. Wesche figures Sciara thomae (Linn.) in his paper on the male genitalia of the Diptera; the cerci are shown as well developed, hairy and bulb-like. The styles in this species are valvular in appearance and on the ventral side of the abdomen, their true position. The ædeagus is a hyaline lobe, not heavily chitinized; the interior forceps are paired blades.

Family Itonididae (Cecidomyiidae)

The species illustrated, Cecidomyia resinicoloides, is fairly typical of the family (figs. 44 and 45); the basistyli form the principal part of the genitalia. In the genus Lobodiplosis there is a much greater development and modification of the ædeagus. In all the forms studied there is a great reduction of the ninth tergite. The dististyli may be larger than in the species figured, as in Colpoda longimana Felt, and the apices may be more or less modified for clasping, as in the genus Porricondyla. The hypopygium of Epimyia carolina Felt, as figured by Felt (N. Y. State Mus. Bull., 165, p. 218), shows a more complex arrangement, the basistyli having two apical appendages, the ninth tergite quite large and considerably modified.

Family Bibionidae

In this family there is more specialization in the male genitalia and more development of the ninth tergite. The ædeagus and appendages in two closely related species, Bibio hirtus and B. nervosus, are quite different, as shown in figures 50 and 51. The clasping appendages of the ninth sternite are simple, the basistyli not entirely separated from the ninth sternite. In Plecia ruficollis there is considerable difference in the styles and an appendage in a pit near the base of the styles (fig. 54). In all these forms there is a noticeable development of the internal genitalia and framework.
Wesche states that in Bibio hortulans (Linn.) and B. marci (Linn.) the ædeagus appears as a plate, with edges bent over and covered by a delicate membrane. The interior forceps are not clearly differentiated in B. hirtus and B. nervosus but may be part of the ædeagus.

Family Scatopsidæ

The Scatopsidae are a group separated from the old family Bibionidæ mainly on the characters of wing venation, but a comparative study of the male genitalia would seem to justify the separation. Wesche describes and figures Scatopsæ notata (Linn.) in his previously mentioned paper. If Wesche's drawings are correct there is some difference in this species and the one known by that name in this country. The cerci are large in this species and all parts of the genitalia present except the spinus. The ædeagus externally suggests the Muscidae, internally the arrangement is more like the Tipulidæ, so the family is almost on the border line between the two groups of the Diptera. The ejaculatory sac and apodeme are well developed (fig. 48).

In Rhegmoclemæ atrata (Say) there is a remarkable specialization of the ædeagus into a long coiled ribbon-like flagellum arising from a broad base (fig. 53); this form of structure is not found again until we come to the Ortalidæ. The ninth sternite is prolonged into an asymmetrical lobe, or a joining of two lobes (fig. 52); the ninth tergite has no styles; the internal forceps are short and pilose.

In Reichertellia collaris Melander the ejaculatory sac is large; the apodemes and basal projections are not developed as in S. notata. The ninth sternite is smaller than the tergite and has style-like projections (fig. 46), the larger pair the styli, with a very small median one and two rather small outer ones. The cerci are rather large.

Family Simulidæ

The male genitalia of this family have been described by Lundstrom and by Edwards. In dried material the structures of the hypopygium are hard to make out. Dipterists have not attempted to describe the genitalia of North Ameri-
can species. According to the writer's experience the males are quite rare in collections. Edwards figures the genitalia of several species (Bull. Ent. Research, vol VI, p. 24) and finds that they possess important specific characters.

Apparently the most important characters are on the basis-
tyli, although the ninth tergite is more or less modified and the cerci are often specifically distinct. Edwards notes that owing to the absence of the ninth sternite these organs have taken up a more ventral position than usual in the Nema-
tocera. Between the ninth tergite and the basistyli is the ædeagus (called the adminiculum by Edwards) and its appendages; it is of use in separating closely related species.

In Prosimulium hirtum (Fries) the seventh sternite is deeply notched on the posterior margin (fig. 57), the eighth sternite absent, and basistyli make up most of the ninth sternite.

In Simulium pictipes the epiproct is small, the cerci are small rounded plates. The dististyli are quite large (fig. 58). The genital framework is quite large and heavily chitinized. The ædeagus is small, flattened, with a flattened, curved, chitinized guard on either side.

Family Blepharoceridae

The genitalia in this group, especially the ædeagus and internal structures, suggest the Tipulidae. The ædeagus is three-pronged and rests on a guard or half sheath (fig. 60) in Bibiocephala grandis O. S. The ninth tergite is small, the hypandrium well developed and with a dististylius or clasper on each side. The seventh and eighth segments are more or less reduced and modified, leaving a large membranous area. The cerci are fairly well developed in B. grandis and in Hapalothrix lugubris, the other species figured (fig. 61).

Family Stratiomyiidae

There is quite a departure from the preceding types in this family. The sternites of the abdomen are well developed in all of the species studied, being almost as large as the tergites.
The genital styles are simple and ventral in *Chloromyia formosa* Scop. and *Microchrysa polita* (Linn.), according to Wesche; the cerci are slender and hairy. The superior laminae are absent. In *Beris pallata* the aedeagus is divided into three prongs at the tip, a central rod and two blade-like guards. In *Beris annulifera* (Big.) the aedeagus is somewhat the same (fig. 62). The guards of the aedeagus are the interior forceps and are found in *Odontomyia hoodiana* Bigot, *O. arcuta* Loew and *Stratiomyia maculosa* Loew (figs. 63, 66, and 67.

In *Sargus viridis* Say the aedeagus is much the same as in Beris. In *Odontomyia hoodiana* there are six visible segments, the true fifth being the last large one, the following segments much smaller, the sixth, seventh, and eighth being normally retracted in the fifth, the ninth projecting. In *Ptecticus trivittatus* Say the first five pairs of spiracles are in the membrane under the anterior corners of the tergites; segments seven and eight are greatly reduced, especially the tergites, as shown in figures 70. The aedeagus is different in shape than in the other genera studied and is not forked; the interior forceps are small.

**Family Tabanidæ**

This family is clearly related to the preceding. The spiracles are in the intersegmental area. The cerci are larger than in the Stratiomyiidae and are hairy, usually broadly rounded. The distisyli are normally bent inward at right angles and the ninth sternite is deeply bifid. The aedeagus is largely covered by the guards, the true penis being probably membranous and exserted by blood pressure. There is a distinct double apodeme and an ejaculatory apodeme attached to the ejaculatory sac (fig. 73).

*Chrysops noctifer* O. S., *Tabanus striatus* Fabr. and *T. punctifer* O. S. were dissected and studied by the writer, and all were found to have genitalia of much the same type, as can be seen from an examination of figures 69, 71, 72, and 73.

In this family the range of variation in species examined is so slight that it is doubtful if the characters will in all cases prove of value in taxonomic work.
Family Pantophthalmidæ

These flies are tropical in their distribution and there are very few specimens in collections in this country; they have been called Acanthomeridæ by many authors in the past. The specimen studied I take to be a male of Pantophthalmus versicolor Austen. The genitalia of this species show a relation to the Rhagionidæ (Leptidæ) and other characters show them to be related to the Xylophaginæ and Ceonomyinæ.

The ñedeagus is comparatively large and simple, with no interior forceps or gonapophyses near the base. The double apodeme is well developed and straight sided. The styles are blunt and plain (fig. 77). The cerci are quite conspicuous and protect the ñedeagus on the dorsal side; between the basistyli there is a sharp projection which also aids in protecting the ñedeagus. The segments of the abdomen are well developed and there is a resemblance to some of the Rhagionidæ.

Family Rhagionidæ (Leptidæ)

The genitalia seem to be in general simpler than in the Stratiomyiidæ. The spiracles are in the intersegmental area between sternites and tergites. The sternites are somewhat reduced in this family but are still well developed. The hypandrium resembles that of the Tabanidæ.

The dististyli are of peculiar shape in Symphoromyia cruenta Coquillett; the ñedeagus consists of two fused pieces on either side of a central part, the latter attached to the ejaculatory apodeme (fig. 74). In Leptis incisa Loew the ñedeagus, framework and apodemes are nearly the same as in S. cruenta. The genitalia in Xylomyia pallipes (Loew) are quite different in general shape from the other forms examined (fig. 75) and this species is aberrant in structures other than genitalic. The styles are short; next to the ñedeagus are two long rods, one on each side, probably the interior forceps; below these is another pair of structures which may be the genital palpi; the ñedeagus is curved and pointed.
Family Nemestrinidæ

Two species were examined in this family and the two are quite different in general appearance; one species, *Rhynconecephalus volaticus* Williston, is shown in figures 78 and 79; the other species, *Nemestrinus ariasi* Lichtwardt, has the eighth and ninth sternites unusually developed, the ninth fitting up against the ninth tergite and inclosing the genitalia; the ædeagus is slender in this species and with the interior forceps projects up through the notch in the ninth tergite. The cerci are longer than in *R. volaticus* and quite slender.

*R. volaticus* has comparatively small genitalia which are, however, quite complex. The abdomen is broad and rounded, the tergites distinctly overlapping and hard to pull apart; the spiracles are in the intersegmental area, with a conspicuous ring of membrane around them; the sternites are broad and not heavily chitinized, the membrane not so easily distinguished from the sternites and tergites in the cleared specimen. There is a narrow plate running from the cerci to the base of the ædeagus. The interior forceps are pointed and the genital palpi, which are larger, are serrated at the tips. The ejaculatory apodeme is quite large (fig. 79).

Family Cyrtidæ

The genus *Eulonchus* has quite simple genitalia, with conspicuous cerci. The ninth tergite curves over the ædeagus and is not split into claspers or surstyli (fig. 84). The two structures at the base of the ædeagus are probably the halves of the hypandrium rather than the interior forceps. The basal apodeme is slender and partly covered by the sheath of the penis.

In *Ogodes* there is a short rounded abdomen with very wide sternites and very little intersegmental membrane; the spiracles are *all in the margins of the tergites*, which curve over the sides of the abdomen. The seventh and eighth segments are reduced to narrow rings and the ninth is small (fig. 82). The figures of the genitalia show that *Ogodes costatus* Loew and *O. albicincta* Cole are distinct species (figs. 81, 82 and 90). In this genus the guards of the ædeagus, probably the ninth sternite with fused basistyli, are peculiar in
shape, dish-like, the aedeagus projecting only a short distance beyond them. There is a central apodeme at the base of the aedeagus and a smaller one on either side. The cerci are small.

In *Opsebius diligens* O. S. the arrangement is more like that in *Eulonchus* than in *Ogcodes*. The ninth tergite is large and covers the most of the structures (fig. 83). There is one pair of inner claspers, the interior forceps.

**Family Bombyliidae**

In the species examined in this family the apical segments of the abdomen are not greatly modified. There is a suggestion of the Cyrtid genus *Eulonchus* in some of the forms. The ninth sternite has well developed basistyli and dististyli that are variously modified and characteristic of the species. The ninth tergite is usually large, cupping over and protecting the inner genitalia. The cerci are usually well developed. A number of species were studied and figured. The greatest variation and some of the best specific characters are to be found in the aedeagus and the chitinization at the base. The apodemes are not very well developed.

There are many genera in the family and no doubt there is a great variation in genitalia. In some species of the genus *Aphæbantus* the hypopygium is very large, but in most genera the genitalia are comparatively small and the characters difficult to make out unless the specimen is dissected and a considerable magnification used. The species dissected and illustrated are: *Bombylius major* Linne (figs. 85, 91, and 92), *Heterostylum robustum* O. S., *Exoprosopa caliptera* (Say), and *Spogostylum ædipus* (Fabr.), shown in figures 88, 94, and 95. *Villa lateralis* (Say) shows much the same form as the other species (fig. 89); in this species there is a structure resembling the “spinus”.

**Family Therestidae**

The general form of the hypopygium is often of great value in the determination of species. The genitalia of some of the species of this family are illustrated in this paper.

The tergite of the ninth segment is usually smaller than the sternite, or hypandrium; both are variously modified in
the family and the anterior and posterior gonapophyses are well developed, often with pile or bristles. The ninth sternite is often split to the base. The cerci are usually quite conspicuous and the proctiger often comparatively large. The styles and the ædeagus with its appendages vary considerably. The ejaculatory apodeme is well developed in some species. The ædeagus and apodemes of Psilopehala hæmorrhoidalis Macquart are shown in figure 98, greatly magnified. In Thereva vialis the interior forceps are well developed (fig. 93) but in Dialineura crassicornis they are absent.

Family Scenopinidæ

Wesche did not study any species of this family, but mentions the description given by Dufour of Scenopinus fenestralis Linn. (“Recherches anatomiques et physiologiques sur les Dipteres”, 1851, Mém. Prés. Ac. Sci. Paris, tome XI, p. 198). Dufour never attempted to name the separate parts of the genitalia.

Scenopinus fenestralis has quite a complex arrangement of structures (fig. 100). The interior forceps and genital palpi are well developed and there are two small projections below these, probably merely outgrowths of the wall of the ninth sternite. The ædeagus is three pronged and the apodemes of good size; the opening of the ejaculatory duct is evidently at the tip of the middle prong of the ædeagus. The seventh and eighth segments are greatly reduced and more or less asymmetrical; the ninth segment is without styles. The cerci are quite large.

In Pseudatrichia unicolor Coquillett the tergal portion of the ninth segment is much larger than the sternal part. The ninth tergite is split to the base on the median line above, the upper corners spread, the cerci set between the halves of the tergite. The sternites of the abdomen are almost as large as the tergites. The ædeagus is large at the tip and quite different in shape from that in Scenopinus fenestralis (fig. 104).

Family Mydaiidæ

Mydas abdominalis and Leptomydas pantherinus have the same general type of genitalia. In L. pantherinus the proctiger is rather large, the cerci small (fig. 101); the ædeagus
is small and protected. There are no appendages on the sternite or tergite of the ninth segment. *L. sponsor* has genitalia closely resembling those of *L. pantherinus*, but the halves of the hypandrium are different in shape. The genitalia show a general resemblance to the Asilidae.

**Family Apioceridae**

In *Rhaphiomydas acton* Coquillett the genitalia are quite simple and no appendages of the ædeaagus are visible in a pinned specimen. In *Apiocera haruspex* O. S. the genitalia are quite complex (figs. 106 and 107); the hypopygium is normally closed in a box-like structure (fig. 105), the ninth sternite and tergite both notched but without articulated appendages. The spiracles are in the membrane near the posterior margins of the segments; the sternites and tergites are normally touching or overlapping; on segments 5, 6, and 7 the spiracles are enormous, especially on the sixth segment, where the spiracle is about eight times as wide as on the third segment. The ædeaagus is rather complex and the interior forceps have apical appendages. The apodemes are well developed and suggest those of some of the Cyrtidae.

In *R. acton* the interior forceps have apical appendages; the cerci are long and rather slender and are obscured by the enormous halves of the ninth tergite when viewed from the side, as shown in figure 108.

**Family Asilidae**

There is a great range of variation in this family, as might be expected in a large group with many distinct genera. Both the ninth sternite and the ninth tergite are large and heavily chitinized. Mr. R. E. Snodgrass published papers on the genitalia of the genera *Dasyllis* and *Laphria* some years ago and noted the inversion of the hypopygium; but it seems that this is not the normal position of the genitalia and that the organs are twisted during copulation, because the neck of the hypopygium is small and weak. In the genera *Dasyllis* and *Laphria* the interior forceps and the genital palpi are both present, each strongly arched dorsally and projecting out of the dorsal notch; the ninth sternite is usually very
large and the floor contains the ædeagus and appendages. The eighth segment is reduced to one small sclerite and the seventh is greatly reduced; the eighth is symmetrical in shape but asymmetrical in position and normally almost hidden within the seventh segment. The ædeagus is usually chitinized and in many species ends in three prongs, the seminal duct evidently dividing. The apodemes of the penis are usually very large. The cerci are well developed.

In *Cyrtopogon præpes* Loew the ædeagus is different than in *Dasyllis* and *Laphria*, not being forked at the tip (fig 109), the apodemes large and the framework strong. In *Pro-machus vertebratus* Say the ædeagus is very large (fig. 111), also in *Asilus occidentalis* Hine (fig. 118). *Erax barbatus* Fabr. has the tip of the ædeagus hook-like (fig. 121), the ninth tergite large and covering the inner organs. Two species of *Lasiopogon* are illustrated, *arenicola* (O. S.) and an undescribed species; these species show a relation to the genus *Cyrtopogon* in the general character of the genitalia as they do in other ways. As can be seen from figures 120 and 124 the shape of the ædeagus is different in the two forms. In *L. arenicola* the cerci are studded with short, backward projecting spines on the inner side (fig. 119).

**Family Dolichopodidae**

Mr. R. E. Snodgrass published a paper on the genitalia of these flies in the Proceedings of the California Academy of Sciences (Ser. 3, III, p. 273, 1904). Several dipterists have made use of the male genitalia in taxonomic work and many forms have been figured. One distinct character of the hypopygium of the Dolichopodidae, as has been pointed out by Snodgrass, is the fact that the body cavity opens into the eighth segment not by a foreamen at the anterior end but by an aperture on the anterior part of the left side. In the species studied the spiracles are all in the intersegmental membrane. Wesche studied several forms in his previously mentioned work; he stated that the ædeagus has processes developed on it in some species. The laminae superiores are not developed; the interior forceps and genital palpi are present. The barbs of the ædeagus in some forms may be homologous with the paraphalli and the hypophalli. The spinus
titillatorius is noted here for the first time in the sequence of the families and Wesche recognizes the genital palpi here for the first time, an interpretation which must be wrong.

The two or three segments of the abdomen preceding the hypopygium may be reduced, distorted or even lacking, segments one to six or seven being the unmodified part. The eighth segment is small and scale-like in some forms, covering the lateral foreamen of the ninth segment; the seventh segment forms the peduncle of the hypopygium, its axis oblique.

The genus Scellus is different from the average (figs. 126 and 127); in this species, according to my interpretation, the usual fifth segment is modified into a remarkable structure that may serve as a clasping organ, or it may be merely a sex ornament.

In most forms the sixth segment is small, the tergite much larger than the sternite, the whole largely retracted into the fifth segment. The fifth segment is seldom modified; in some forms it is largely composed of the tergal portion, as in Liancalus similis Aldrich (fig. 128).

In Scellus monstrosus O. S. there are no true claspers present on the genitalia (the styles not modified for holding), but the fore tibiae are modified for holding the female. In the genus Dolichopus the cerci are developed into remarkable structures sometimes known as “fans”; they are usually distinctly different in each species and often possess strong bristles (figs. 131, 132).

Family Phoridae

We find considerable asymmetry in the genitalia in this family, but the apical portion of the abdomen is usually not so remarkably modified as in most of the Dolichopodidae, Pipunculidae, and Syrphidae. In Phora velutina Meigen the eighth and ninth segments are asymmetrical; the ninth sternite is quite different on the right and left sides (fig. 135); the appendages at the base of the aedeagus are also asymmetrical. In this species the ninth tergite is large and the cerci well developed.

In Conicera aldrichi Brues there is a twisting of the hypopygium to one side and against the preabdomen; the seventh
and eighth segments cannot be made out and may be fused with the sixth segment or obliterated. The ninth sternite and tergite are more or less fused, the large styles apparently tergal. The ædeagus is large and shaped much as in the preceding species. The ejaculatory apodeme is chitinized, quite conspicuous, anchor-shaped. The sternites are much smaller than the tergites, the small spiracles being in the membrane between.

An undetermined species of *Apiochæta* from Apia, Samoa, has the peculiar proctiger noted in some other species of the genus; it is a single organ (called the "anal tube" by Lundbeck) with two apical appendages which are seen to be pubescent bristles under the high power microscope (fig. 133). The separate sclerites representing the cerci cannot be made out. There is some torsion of the hypopygium from right to left, the dorsal side turned almost ventral. The genitalia are very small and difficult to make out.

In *Apiochæta rufipes* Meigen the proctiger is nearly like that in the preceding species, but the appendages are not at the exact tip and are bare of microscopic pile; the large bristles of the abdomen are all microscopically pubescent. The ninth tergite is much larger than the sternite, as in the preceding species; the internal genitalia (ædeagus and gonapophyses) are very small and twisted from right to left within the ninth sternite, as shown in figure 134.

**Family Braulidæ**

A specimen of the rare fly *Braula caeca* Nitsch was loaned by Dr. Aldrich from the United States National Museum collection. A separate family has been erected for this grotesque little species and in the past it has been placed at the end of the series of Diptera. Recent studies have shown the fly to be closely related to some of the wingless, parasitic Phoridae and it has been placed in that family by some dipterists. Without entering into a discussion of the general characters, I would place the species in a separate family following the Phoridae.

This small parasite was studied by Wesche, who stated that he could trace the genitalia and that they appeared to be more muscoid than of a type related to *Melophagus*. The
genitalia are quite different from those of any of the Phoridae studied.

The hypopygium is comparatively large, with a large membranous portion. The first sternal plate is very large, the three following plates quite small, narrow; the tergites are very wide and curve under the abdomen for some distance so that although the spiracles are on the tergites they are ventral in position. The sides of the tergites are separated from the main dorsal portion so that they give the appearance of pleural plates. There are five tergites as viewed from above, but from the side one can clearly see six plates. As seen from above the actual first tergite is hidden by the second. I can find only six pairs of spiracles. The segments beyond the sixth are included in the hypopygium, which is largely membranous. The cerci are quite apparent and there is a central structure which I take to be the aedeagus (see fig. 136); on either side of the aedeagus there is a slender guard, possibly the interior forceps. The apodemes are quite long and show through the membrane when the specimen is cleared.

**Family Lonchopteridae**

Aldrich notes the rarity of males of *Lonchoptera* (Psyche, vol. XXV, p. 33), having only two in his collection; in one season he collected 2,652 specimens and got no males. Evidently our common species reproduces parthenogenetically. Lundbeck (in Diptera Danica, pt. V, p. 1-18, 1916) recognizes three species in Denmark; the females of *L. furcata* were common but no males were found and only six males of the species were known in collections. Lundbeck describes the general form of the hypopygium in detail and in the species he studied there was a close relation shown to the Doliocopodidae, the hypopygium being large and bent in under the venter, with a complicated median organ, the penis and its sheath; to each side of this organ were attached two pairs of variously shaped inner lamellae or gonapophyses.

I was able to study a male of an undetermined species of *Lonchoptera* from Alaska, loaned by Dr. Aldrich from the National Museum collection. The sternites beyond the fifth are not chitinized and the median portion of the fifth is partly

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membranous, the hypopygium folding under the abdomen against this segment. The sixth tergite is large and folds under on the sides, protecting the membranous part of the hypopygium. The seventh tergite is very small, forming the neck of the hypopygium, the eighth tergite is lost or fused with the ninth. The ninth segment is comparatively large and is symmetrical, the tergal portion larger than the sternal. The guards of the ædeagus, which may be the dististyli, but which have the position of interior forceps, are quite large and project beyond the rest of the genitalia (see fig. 144). The structure which is evidently the ædeagus in this species is not complicated and pointing somewhat backward, as in the species described by Lundbeck, but is rather short and membranous (unless the specimen I have figured is broken).

**Family Platypezidæ**

In *Platypesa velutina* Loew the seventh and eighth segments are greatly reduced, the seventh sternite being lost, the eighth consisting of a narrow ring. The proctiger and cerci are well developed. The eighth tergite is asymmetrical, being larger and differently shaped on one side than on the other. Figure 143 shows the floor of the hypandrium from above, the ninth tergite removed. The styles and cerci in *P. velutina* are smaller than in *P. agarici* Willard (fig. 145) and the ædeagus is much shorter and curved distad; two long style-like prolongations on the ninth sternite (dististyles?) serve as guards to the ædeagus.

**Family Empididæ**

The styles are present in most of the species of this family but according to Wesche are absent in *Empis stercorea* L. The cerci are usually not well developed. The spiracles are in the intersegmental membrane and there are thin spots along the sides of the tergites, as in some of the Dolichopodidæ, giving the appearance of large spiracles.

The ædeagus is usually quite slender and I have seen no species where it was forked; in some species there is a long flagellum, called a “talædeagus” by Crampton. In *Rhamphonymia* the long apical part of the ædeagus is curved for-
ward and rigid. All the species of this immense genus that were studied are readily separated by genitalic characters. In *Hilara cilipes*, figured by Wesche, the aedeagus has thorns or barbs pointing forward; Wesche calls these barbs in *Empis stercorea* the paraphallus and hypophallus; these structures are not present in any of the forms I have studied.

In *Empis aldrichi* Melander the seventh sternite has two clumps of comb-like spines (fig. 140), and the segments beyond are normally retracted within this large seventh segment; the aedeagus in this species is remarkable, half coiled and spring-like as can be seen from the figure; the basistyli and surstyli are about the same size. In *Hybos tripexus* there is great asymmetry, the right side of the hypopygium being much more developed than the left; the cerci are very small.

**Family Pipunculidæ**

In this family we find distinct asymmetry of the abdominal segments reaching back to the preabdomen, and considerable torsion, as in the Syrphidæ, to which family the relation is evident. The genitalia are covered up by the segments which are turned under and against the venter. In the species studied the eighth segment is grown to the sides of the sixth and seventh in twisting over (fig. 151). The division of the sternites is shown in figure 151.

In all of the forms studied the aedeagus ends in three forks, the central one evidently the continuation of the seminal duct. In *Chalarus spurius* (Fall.) there is a slightly different structure (fig. 150). The ejaculatory apodemes are remarkable in shape in the species dissected and are quite distinct for the species. The aedeagus rests in a half sheath in *Pipunculus* sp. no. 2 (fig. 153); in *Pipunculus* sp. no. 1 there are two oval guards at the base of the aedeagus (fig. 147), probably the modified interior forceps.

**Family Syrphidæ**

Wesche described the structures in this family in some detail. Dr. C. L. Metcalf has recently written a fine paper on the male genitalia of the Syrphidæ and the student is referred to this work for a detailed discussion. The group is remark-
able for the almost universal asymmetry of the last four segments; the division between the preabdomen and postabdomen is usually quite distinct. In the study of this family I have figured ten species, distributed in eight genera.

The styles are well developed and show considerable variation; the cerci are usually rather small. The laminae superiores are absent. The aedeagus may be flexible and membranous or it may be more or less chitinized, sometimes in plates; the base of the aedeagus is well developed in some species, protecting or serving to rotate the organ. The paraphalli may be represented by processes, as by two blades seen in *Eristalis tenax* (Linn.) shown in figure 154. The interior forceps in *Lasiocephus pyrastri* (Linn.) take the form of a band around the base of the aedeagus.

The genitalia in the Syrphidae fit into a hollow or "genital pouch", which is illustrated in figures 155 and 158, and unless dissected out or pulled away from the cavity in which they fit these remarkable structures are hidden from view. The great range of variation in the structure of the aedeagus is shown in figures of *Mesogramma geminata* (fig. 159), *Eristalis tenax* (154), *Lasiocephus pyrastri* (160), *Eristalis vinctorum* (164), *Eristalis caecus* (161), *Volucella esuriens* (156), *Caliprobola pulcher* (162), and *Melanostoma obscurum* (165).

**Family Conopidae**

In this family there is no asymmetry in the organs making up the male genitalia. The genitalia in most forms are protected by the bending forward of the abdomen against the venter of the preabdomen. The eighth and ninth sternites often have combs of spines on the posterior margins which may aid in clasping the females. The abdomen in many forms is more or less rounded, but in some genera (*Conops, Physosephala, and Stylogaster*) it is very slender. The abdomen of *Physosephala affinis* Williston is shown in figure 176; the sternites are poorly developed, there being none on the first three segments, the tergites curving down and protecting the membrane of the venter.

The cerci in all the forms studied are small, as in *Myopa rubida* and *M. seminuda* (figs. 172 and 178). The aedeagus...
in all the species examined is quite large, blunt and membranous, with characteristic protuberances and folds, possibly homologous with the paraphalli and hypophalli (fig. 168). In Occemyia modesta Williston and O. abbreviata Loew (figs. 169 and 170) the interior forceps are well developed; the apodemes are very peculiar in shape, especially the large basal part of the double apodeme, which is fused and unusually developed.

In general the genitalia in the Conopidae are not nearly so complex as in the Syrphidae and the specific differences are less marked.

The Muscoidea

The Muscoidea, both calyptrate and acalyptrate, are greatly specialized and cannot be arranged in any graded series to show a theoretical line of development from a generalized form. In a manuscript paper on the genitalia of the Muscoidea (previously mentioned by the writer) Mr. R. E. Snodgrass noted the fact that the Phycodromidae seem to approach the generalized condition, but perhaps this is only an apparent generalization of the male hypopygium.

The abdomen is apparently quite short in many of the Muscoids owing to the reduction of segments five to nine. The first and second tergites are sometimes fused but the sternites are distinct; the fifth sternite is often deeply notched, the shape usually of specific value. In the study of the segments beyond the fifth it appears that very few of the muscoids have the sixth sternite well developed. The segment following, usually the seventh, is present in some as small plates, in others absent; in many forms the apparent eighth tergite may be regarded as the seventh and eighth fused. In the Helomyzidae there is a tendency to a fusion of the sixth and seventh tergites.

The ninth segment usually has a large convex tergum terminating the genital part of the abdomen, a smaller sternum, generally concealed within the eighth sternite. The general structure of the hypopygium varies considerably, but there is no great departure from the form seen in some of the preceding
families. The ædeagus is usually large, often complex in structure and in most all forms with two pairs of gonapophyses at the base, the interior forceps and the genital palpi.

Family Cestridæ

This family is clearly related to the other Muscoidea in the general structure of the male genitalia, but is less specialized, the genitalia, as well as many other parts of the body, having a small range of specific variation. The genitalia are comparatively small.

The genitalia of Gastrophilus intestinalis (De Geer) are illustrated in figures 171 and 173; the ædeagus is short, thick, membranous, with the interior forceps well developed. In Hypoderma lineata De Vill. the abdomen shows only five sternites when the genitalia are not extruded, the last tergite covering the genital part of the abdomen; the sternites are rather small; tergites six and seven are evidently fused and are about the size of the eighth. The cerci are well developed. Most of the ædeagus is chitinized, the apex membranous; the interior forceps and palpi are present (fig. 179).

In Cuterebra americana Fabr. the first five spiracles are in the tergites and have a chitinous rim, the seventh spiracle is in the membrane between the sternite and tergite, the sixth is in the sixth tergite (fig. 177). The genital portion of the abdomen suggests the genus Glossina, the genital organs being normally folded in against the abdomen and entirely concealed. The last large tergite is apparently the fifth and sixth fused, the seventh forms part of the plate set into the fifth, the eighth is small and crescent-shaped, set into the seventh, the ninth tergite is still smaller, as shown in figure 177. The ædeagus is heavily chitinized and there is a blunt spinus; the interior forceps and genital palpi are present (fig. 174).

Family Tachinidæ

The Tachinidæ (as limited by Williston and early dipterists) are much like the Museidæ in the general structure of the male genitalia and also like the next two families, the Dexiidæ and Sarcophagidæ. The hypopygium is not usually large and is folded in against the abdomen in most forms so
that the structures are not easily discernible. In the preparation of this paper I have dissected eight species belonging to seven genera.

The spiracles are in the tergites, except where these are greatly reduced in the genital region. The ninth tergite is well developed and often quite long and pointed. There are usually two claspers, or gonapophyses, on the ninth sternite. The ædeagus is subject to great variation, as shown in figures 182 to 188; the paraphalli and other appendages are often difficult to trace.

There may be some question as to the correct interpretation of the paraprocts and surstyli as illustrated and discussed in this and the following families of muscoid flies. The structures labelled pp (figs. 182, 184, etc.) were at first considered surstyli by the writer, but after some discussion with other workers interested in the morphology of the muscoid genitalia and some subsequent study of specimens it was decided that these parts correspond to the paraprocts. In some species these paraprocts may be fused into a single median structure.

Family Dexiidæ

_Thelaira leucozona_ Panzer and _Myiocera tibialis_ Desvoidy were studied and figures 191 and 192 show the more important structures. The paraprocts and surstyli are quite clearly shown. Figure 192 shows the distinct separation of the parapodial plate (pp) from the ninth tergite. The paraphalli and spinus are well developed, also the apodemes of the ædeagus, but the ejaculatory apodeme is separated some distance from the base of the ædeagus and is small.

Family Sarcophagidæ

Aldrich, in his paper “Sarcophagidæ and Allies”, based his classification of the family very largely on the male genitalia. The specific differences are often remarkable in this group and males are usually easy to place when the genitalia are studied. The hindmost of the genital structures are the large, heavily chitinized organs on the sides of the anus; these two prominent organs were called “forceps” by Aldrich and are here considered the paraprocts.
Wesche mentions certain characters in this family and notes that the laminae superiores are usually quite marked in Sarcophaga, often with long lateral processes. The spinus is absent in some species. The drawing of Sarcophaga communis Parker (fig. 199) will illustrate the general arrangement of the aedeagus and appendages as well as any. There is a great specific variation as can be seen from a comparison of figures 189, 190, 193, 197, 198 and 199. Wesche includes this group, with several others, in the old family Muscidae.

The hypopygium is often strongly contrasting in color with the rest of the abdomen, being red or yellow in many species. The fifth sternite is often deeply notched as in the Muscidae; the reduction of the right side of the sternites in the genital region is not very noticeable; the spiracles are as in the Tachinidæ and Muscidae. The genital chamber is usually shallow. The cerci are usually small and embedded.

Family Muscidae

A number of genera are included here which are now generally grouped together in a separate family, the Calliphoridae; the following genera here considered are in this category: Cynomyia, Lucilia, Phormia, and Polenia.

In this family only five segments are normally visible before the genitalia. The first tergite is fused with the second, the first sternite small but free. The hypopygium is retracted into the fifth segment, the fifth sternite deeply notched in many species; the seventh and eighth segments are greatly reduced, fused, or one of them lacking. The ninth segment is in some, as in Lucilia, a semicircular band covering the sides and top of the sclerite representing the sternum; the flat, invaginated cavity in the ninth segment accounts for the unusual position of the sternite. The actual floor of the genital chamber is formed by the invagination of the cavity of the eighth segment.

Mr. Robert Newstead has recently published papers on the male armature of the species of the genus Glossina. The armature is hidden when the ninth segment is closed against the eighth, the anal groove and membrane showing, but not the cerci. Newstead uses some new terms in describing the structures of the male genitalia, but few of these are adopted.
in the present paper. Wesche made a more or less extensive study of the male genitalia in this family and noted the good specific characters.

In Glossina, where the whole last segment is turned in under the abdomen, the gonostyli rest against an arched, horny band which represents the superior laminae; this is absent in G. palpalis Desv. In G. tachinoides the extremity of the aedeagus has membranous wings studded with minute plates, capable of inflation and erection.

The paraphallus is usually well developed in the Muscide and may be more or less serrated or otherwise modified; in Glossina the paraphalli together with part of the sheath form a framework which supports an elaborate sensory apparatus and protects the orifice of the ejaculatory duct. The hypophallus is generally present, as in Pollenia rudis (fig. 211), and has the appearance of lateral plates in Calliphora. The spinus is generally present, as are the interior forceps; the genital palpi are occasionally absent, but are greatly developed in some forms.

In Musca domestica the preabdomen consists of four apparent segments; the first segment is reduced to a small ventral plate; the second segment is largest; the sternal plates are small and median. Immediately following the fifth segment is the postabdomen, largely covered by the fifth tergite. In this species the central margin of the ninth sternite carries the aedeagus, which has a short, lobed, membranous tip. The last segment (proctiger) of M. domestica is a membranous area with an anal groove and two small plates representing the cerci. In this species there is no paraphallus or hypophallus.

Various forms of genitalia in this family are shown in the drawings of Graphomyia maculata (Scop.), Cynomyia cadaverina Desv., Phormia regina (Meig.), Myiospila meditibunda (Fabr.), Stomoxys calcitrans (Linn.), Musca domestica Linn., Pollenia rudis (Fabr.) which are illustrated in figures 195, 196, and 200-211.

Family Anthomyiidae

Wesche described the genitalia of a few species in this family. Hyetodesia obscurata Meigen is said to have soft haired, bulbous tubercles representing the superior laminae.
In *Hydrotca*, where the legs are modified to hold the females, the claspers are poorly developed.

In most species the sternites are small and in many the fifth sternite is modified and characteristic of the species. In *Hylemyia alcathoe* Walker the sixth and seventh segments are asymmetrical and greatly modified; segments 2, 3, 4, and 5 have spiracles in the tergites; the sixth sternite is pushed around on the left side and the seventh sternite is missing; the eighth sternite is a narrow strip on the left side (figs. 212 and 213). The seventh segment is of interest here as it is fused with the anterior margin of the eighth tergite, except the lower end, which is an oval plate with a dark margin all around; the seventh spiracle is present on the left side only. The cerci are rather small.

The paraphalli and the hypophallus are present in some of the species, also the genital "palpi". The "palpi" are absent in *Fucellia fucorum* Fallen, the places marked by single bristles. In *Phorbia fusciceps* (Zett.) the fifth sternite is even more deeply notched than in *Hylemyia alcathoe*; the surstyli are long and slender, also the apodemes (fig. 215). In *Phorbia brassicae* there is the same plan of construction, the genitalia much as in *P. fusciceps*. In *Ophyra leucostoma* there is a notable difference in the general appearance of the genitalia; the styles are short and blunt and the ædeagus is short and thick; the whole hypopygium is rather small, the sixth, seventh, and eighth segments much reduced.

**Family Scatophagidae**

The fifth sternite in this family is of specific importance, being variously modified on the posterior margin; there is considerable asymmetry beyond the fifth segment; the sixth and seventh segments are very short and the genitalia normally hidden under the edge of the fifth segment. In the genus *Scatophaga* the structures which I take to be the paraprocts are rather large and heavily chitinized (fig. 216) and the styles, evidently surstyli, are pointed and curved near the tips. *Scatophaga furcata* Say is much like *S. stercoraria* in the form of the genitalia, but with some remarkable differences in the apodemes, the ejaculatory apodeme being comparatively enormous in *furcata* (fig. 218). In this species there are two
long bristles on the “palpi”. The general structure in *S. stercoraria* is shown in figure 217.

*Scatophaga crinita* Coquillett is much like *S. stercoraria* in the form of the genitalia, the apodemes being much the same, but the ædeagus is specifically distinct; the anal area is largely membranous, the chitinized cerci much smaller than in the preceding species. In *S. islandica* Becker the ædeagus and guards are much the same as in *S. furcata*, the apodemes much smaller. The fifth sternite is shown in figure 214.

Wesche found that the hypophallus is often developed in this family and that the palpi often carry long setae. In *Norellia spinimana* these palpi take the place of the interior forceps in position as well as in function.

In *S. stercoraria* there are only three apparent segments back of the fifth and the seventh and eighth segments are fused; the sixth tergite is short and present on the right side only; the sternite corresponding to the seventh and eighth tergites is developed on the left side and atrophied on the right; the ninth segment, as in the Tachinidæ, is a complete circle.

In a species of *Cordylura* examined the fifth segment is modified on the sternite into two structures which presumably are of use as claspers and which also serve to guard the hypopygium when it is folded against the venter (fig. 219). The styles are large and complicated and the paraprocts well developed. The ædeagus has an apical slender appendage. *Coenosia ausoba* Walker has the fifth sternite developed much as in the preceding species, but the structures here are probably not of use as claspers, merely serving to protect the genitalia by holding the tip of the ninth segment in place against the venter.

**Family Helomyzidæ**

This family clearly shows a relation to the Trypetidæ and Ortalididæ. There is considerable asymmetry and variation in the genital portion of the abdomen.

In *Helomyza limbata* the ædeagus is quite large and modified at the tip (fig. 223); the posterior margin of the sixth and seventh combined sternite is curiously irregular, probably due to the pressure of the ædeagus. The cerci are quite large.
The aedeagus is twisted in Leria cinerea Loew and arises as two chitinized strips (fig. 221); the interior forceps are well developed; the proctiger is unusually developed. In Anorostoma grandis Darlington the aedeagus is twisted and curiously modified (fig. 226); the proctiger is very large (fig. 225). In Leria serrata (Linnaeus) the aedeagus is quite long and slender (fig. 222), but not at all enlarged at the tip as in the Trypetidæ. In this species as in L. crassipes Loew there is considerable asymmetry of the genital segments (fig. 227).

Family Clusiodidæ

In this family segments one to five form the principal part of the abdomen, judging from Clusia lateralis Walker, the only species studied. The sixth segment is slightly asymmetrical, the sixth and eighth segments hollowed out on the venter for the reception of the genitalia when folded against the abdomen; the eighth and ninth segments are symmetrical. The aedeagus is rather long and slender, with a bend near the middle (fig. 220). The seventh segment is present only on the left side, the spiracle placed on it; the other spiracles are in the intersegmental membrane. The cerci are comparatively small.

Family Borboridæ

The hypopygium of Copromyza equina Fallén is rather small, symmetrical and simple (figs. 232 and 233). The fifth segment is normal, the sixth represented by an asymmetrical sclerite on the venter; the seventh and eighth segments are apparently lost. The aedeagus is short, more or less membranous; the apodemes are well developed (fig. 230).

Segments 6, 7, and 8 are asymmetrical in Leptocera limosa, the sixth sternite largely hidden by the large fifth sternite; the seventh tergite is present on the left side only, the seventh and eighth sternites apparently obliterated. The ninth tergite and sternite are largely fused; the styles are blunt and plain; above the styles on each side are two spine-like projections which may serve as claspers. The proctiger and cerci are small. The interior forceps are well developed, the aedeagus small and membranous. In L. atra (Adams) the large fifth
sternite has a wide, square excision on the posterior margin; the sixth, seventh, and eighth segments are much the same as in *L. limosa* (Fallén); the spines of the ninth tergite are very short and the styles thinner. The ædeagus, with its appendages and apodemes, is shown in figure 234.

**Family Phycodromidæ**

*Cælopa frigida* Fallén was the species dissected and studied as a representative of this family. The hypopygium is normally retracted within the fifth segment, but may be extruded as figured (fig. 229). The segments 6, 7, and 8 are asymmetrical, the hypopygium itself twisted forward on the left side; the four plates between the fifth and eighth segments represent two segments, as evidenced by the spiracles; the seventh tergite is reduced to a small elongate plate on the right side (not visible in the figure given). The cerci are small and united below, forming together a horseshoe-shaped band.

In general the genitalia are very complete. The ædeagus arises from above the ninth tergite (see fig. 224 for details). The two pecten-like lobes are probably the hypophallus, the plate at the base possibly the paraphallus, or these may represent the interior forceps. The penis is membranous, twisted, and arises from a sac-like structure.

**Family Sciomyzidæ**

*Melina vitalis* Cresson shows a modification of the sixth, seventh, and eighth segments, which are small and asymmetrical, being developed on the left side. The spiracles are in the pleural membrane. The genitalia are quite well developed and have inner and outer appendages functioning as claspers. The ædeagus is short and the cerci small. The interior forceps and the “palpi” are present and the framework for the ædeagus and appendages is characteristic. In *Dictya umbra-rum* (Linn.) there is not so much asymmetry in the genital segments; the seventh segment is well developed and the fifth sternite has a dense covering of hair-like spines. The interior appendages are quite heavily chitinized. The ædeagus is short and membranous (fig. 238). The ædeagus and appendages of *Tetanocera vicina* Macquart are shown in figure 236.
Family Rhopalomeridæ

Mr. C. W. Johnson kindly loaned a specimen of Rhopalomera femorata Fabricius for study. The family seems to be nearer to the Scionymidæ than to any other in the structure of the genitalia, and should certainly not be placed between the Ortalididæ and the Trypetidæ, as has been done by many dipterists in the past. The resemblance to the Ephydridæ is only superficial, being largely confined to the appearance of the face.

The small spiracles are in the intersegmental area along the sides of the abdomen. Segments 6, 7, and 8 are greatly reduced and modified, the left side being more extensively chitinized, as in many other families. The fifth sternite is deeply notched and with strong spines on the posterior margin; the sixth segment is greatly reduced, especially the sternite (fig. 239), and a small sclerite near it is probably the seventh sternite. Normally the ædeagus and appendages are sunk between the styles and in a hollow of the ninth segment, but they are attached to a membranous base and in figure 240 are shown pushed up to give a view of all the structures. The double apodeme differs from that seen in the Ortalididæ and Trypetidæ.

Family Sapromyzidæ

In the Sapromyza species studied the principal part of the abdomen consists of six visible pregenital segments (1-6), which are unmodified. The tergites are large, the sternites small, with a large membranous area between; there are only five pregenital sternites; segments 7 and 8 are normally concealed in the sixth segment and are combined into a narrow ring. The ninth sternal plate is at the base of the ædeagus. Snodgrass, in a manuscript paper, figured a long membranous ædeagus in Sapromyza flavcola, but in the species studied by the writer the ædeagus is quite different, being very short (fig. 241). In this family the spiracles are in the membrane below the tergites.

In Caliope gracilipes Loew the genitalia are very different, suggesting the genus Lonchæa, described further on, and also some of the Agromyzidæ; the ædeagus and appendages are heavily chitinized.
Family Lonchæidæ

This family has only recently been separated from the Sapromyzidæ by some authors. Wesche uses Toxoneura multiebris as an example of the family and gives an illustration which shows a close relation of this species to Palleoptera terminalis Loew, a form which has a remarkable Ædeagus (fig. 244). Wesche states that Palleoptera ustulata has an unusual Ædeagus. In T. multiebris there is a spinus titillatorius at the base of the long flagellum; in Palleoptera ustulata and terminalis there is a structure on the enlarged apical part of the Ædeagus which Wesche believed to have the same function; it can hardly be the same structure morphologically. The interior forceps and “palpi” appear to be in an atrophying state.

Family Ortalididæ

The Ædeagus in this family is very long and complicated, but it is usually hidden under a fold of membrane in the fifth segment, being normally coiled and very difficult to straighten for the purpose of examination. In Tetanops aldrichi Hendel the genitalia are very nearly the same as in Anacampta pyrrhocephala Loew, as can be seen from figures 248 and 250. In Euxesta thomæ the general plan of structure is about the same as in the two preceding species, but the Ædeagus is shorter and the fringe very fine; the reduction of the sixth and seventh tergites is about the same.

In Chrysomyza demandata (Fabricius) the genitalia are of the usual form; the Ædeagus is very long and the apical third is much enlarged and modified at the tip (fig. 245). In Seoptera vibrans the genitalia are typical; the basal half of the Ædeagus is slender and smooth, the apical half enlarged and with a dense fringe of rather long pile; the cerci are large. In Rivellia viridulans Desvoidy the Ædeagus is more like that usually found in the Trypetidæ, there being no fringe of pile (fig. 252). In Rivellia f-fasciata the structures are essentially the same as in R. viridulans, but the bifid portion of the Ædeagus begins very near the bulbous portion, and there are other slight specific differences. Enicoptera proditrix has the main claspers or styles much as in Anastrepha ludens (Loew), but not so pointed; the Ædeagus is slender and smooth until near
the tip, where it is suddenly enlarged and modified as in the family Trypetidae, and it is not in a tight coil as in most of the Ortaliidae examined; the apodemes are quite slender. The genitalia of *Richardia podagrícia* (Fabr.) suggest those of *Enicoptera proditrix* in general appearance, but the cerci are smaller and the apex of the ædeagus different; here the appendage inside the ditistylus is distinctly separate, more slender, toothed at the tip and forming a guard to the ædeagus. In *Melieria occidentalis* Coquillett the ædeagus has tooth-like structures at the base of the flagellum and long blade-like spines near the tip (fig. 247).

**Family Trypetidae**

The figure of *Epochra canadensis* Loew will give an idea of the general appearance of the abdomen in this family and the relation of the parts of the genitalia (fig. 255). There are apparently only four visible tergites, but the first large sclerite is composed of the first fused with the second; the fifth sternite is large and variously notched on the posterior margin in different species of the family, the sixth segment normally retracted within the fifth. The ædeagus is long and slender in *E. canadensis* as in all other species of the family examined, the tip enlarged and more or less chitinized. There is an asymmetrical depression on the right side of the abdomen. The ædeagus of *Euaresta æqualís* Loew is shown directed posteriorly in figure 253; it is usually curved and bent up over the ninth tergite.

The anal area is usually large, membranous and protruding in this family. There are no apparent cerci in *E. æqualís*, but cerci are present in *E. canadensis* and *Eutreta sparsa* Wiedemann and there are very thin chitinous strips on the sides of the anal opening in *A. ludens*. The ejaculatory apodeme is usually very large.

The genitalia of *A. ludens* are much like those of *Eutreta sparsa* Wiedemann in general shape; the ædeagus is proportionately about twice as long and the membranous anal area even larger than in *E. sparsa*; the ædeagus in this species is actually longer than the abdomen. The ejaculatory apodeme is not fan-shaped but rather slender. *Dacus cucurbitae* has genitalia like those in the preceding species; the ædeagus has
an enlarged tip and is considerably modified. *Ptilona brevicornis* has appendages on the inner side of the styles; the basal half of the ædeagus is slender and on the median portion there is a brush of hairs extending only a short distance; the tip of the ædeagus is enlarged and considerably chitinized and the extreme apex slender and hyaline. *Eurosta comma* has genitalia more or less typical of the family; the small appendages inside the genital styles are separate and free moving; the ædeagus is nearly the same as in *Eutreta sparsa*. In *Anastrepha fratercula* the ædeagus is specifically distinct in structure and proportionately shorter than in *A. ludens*.

**Family Micropezidæ**

The normal appearance of the dried abdomen in a specimen of *Calobata alesia* Walker is shown in figure 258, the appearance after boiling the pinned specimen in KOH and stretching to its full length is illustrated in figure 259. The spiracles are plainly in the membrane between the tergites and sternites. There are six main segments in the preabdomen (1-6), and back of this there is more or less modification. In *C. alesia* and *C. univitta* Walker there are remarkable claspers present on the fourth sternite and it is significant that we find no claspers on the ninth segment. The ædeagus is variously modified in the species studied and in *C. alesia* and *C. univitta* it is branched at the tip (figs. 259 and 261); the appendages probably represent the hypophallus and paraphalli. The cerci are small and inconspicuous in the three species studied. *C. antennipes* has a somewhat different structure of the abdomen, the ventral claspers organs being on the fifth sternite and rather slender; the ædeagus is not branched at the tip (fig. 260). The eighth segment is well developed in all of these species, but the seventh tergite is developed on one side only.

Cresson's figure of *Micropeza ambigua* (1908, Trans. Amer. Ent. Soc., XXXIV, 13, pl. 1) shows the claspers to be on the fourth sternite in that species. Cresson also figures claspers of the males of several species of *Calobata* in the paper mentioned, the structures being specifically quite distinct.

April 27, 1927
Family Sepsidäe

In *Sepsis similis* Meigen there are only six visible segments; the first apparent segment is long and represents two actual segments, the fused first and second. The apparent fourth segment is actually the fifth; the seventh and eighth segments have disappeared. The spiracles are in the membrane just under the tergites. *Sepsis violacea* Meigen is very close to the preceding species in the form of the genitalia. Wesche states that the superior laminae may be well developed in this family; he figures a species of *Nemopoda* which has a very complicated aedeagus, the paraphalli being quite well developed. The paraphalli are present in *S. violacea*, the hypophalli very small (fig. 263); the double apodeme is distinctly double at the base and more or less fused with the ninth sternite; the ejaculatory apodeme is large. The ninth sternite is small and the clasping structures are apparently the surstyli.

Family Piophilidäe

This family has commonly been placed with the Sepsidäe, but Dipterists have recently shown that the two groups can be separated into two homogeneous groups. There are three genera in North America, of which *Piophila* is the best represented. Melander states that in *Piophila* the aedeagus is sometimes long and curled; in *Piophila nigricoxa* Melander the aedeagus is not fringed, but in *P. nigriceps* it is thick and is provided with four longitudinal fringes of long yellow hair. This is evidence of a relation to the family Ortalidäe.

In *Piophila casei* the first five segments form the principal part of the abdomen. The sternites are quite large and the spiracles in the intersegmental membrane. The apical segments are asymmetrical, the sixth, seventh and eighth fused and pulled to the venter where they join to the ninth tergite. The genitalia are twisted sideways, the ninth segment large and the aedeagus long and fringed on the basal portion (fig. 264).

Family Psilidäe

In *Chyliza leguminicola* Melander the first segment is small, then there are five large segments making up most of the ab-
domen; there are six spiracles marking segments one to six; the sixth sternite is split to the base. In the membranous area between the sixth and ninth segments there is a narrow chitinous strip on each side which may be considered the seventh segment. One spiracle is in the margin of the sixth tergite, the others are in the membrane. The eighth segment is represented by a small rectangular piece, a tergite, attached to the ninth tergite (fig. 269) and by two narrow strips, probably the sternite. The ædeagus is membranous and very short.

Chyliza robusta Coquillett is very near the preceding species. The eighth tergite is reduced to a narrower strip and the ninth segment is different in shape; the apodemes and framework are much the same. The ædeagus with its appendages is different, as shown in figure 270.

Wesche mentions that the males of Loxocera albiseta (Schrank) have small genitalia of an indefinite character, and he gives no further information on the family.

Family Diopsidæ

In Diopsis subnotata Westwood the genitalia are difficult to homologize. The ædeagus is comparatively small and the genital framework unusual in shape (fig. 267, one side cut away in the drawing); the double apodeme is large and fused; the styles are simple and rather small. The membranous anal area is large.

In Sphyracephala brevicornis Say, the only North American species, the first three abdominal segments are long, the first and second segments being fused and almost as long as the rest of the abdomen. The sixth, seventh, and eighth segments are greatly reduced but there is no asymmetry. The surstyli and the cerci are well developed. The double apodeme is very long, the ædeagus and interior forceps are quite small (fig. 268).

Family Ephydridæ

In Ephyma millbraæ Jones there is a curious modification of the abdomen beyond the fifth segment and the cerci are apparently at the base of the ninth tergite, which is developed
horizontally. The sternites are much reduced. The intersegmental membrane is very tough and thicker than usual and the minute spiracles are in the edges of the tergites (possibly an adaption to hydrophytic conditions); around these spiracles are many small thin spots which are more or less transparent. The general appearance of the abdomen of *Ephydra millbœ* is shown in figure 274.

In *Ephydra gracilis* the plan of construction is the same, but there are specific differences. In *Parydra bituberculata* Loew the genitalia are relatively smaller and simpler; the sternites are larger; the ãeëeagus and appendages are shown in figure 271. In *Ochthera mantis* (De Geer) the sternites are larger than in the preceding species, the hypopygium moderate in size and folded up against the venter, reaching to the base of the fourth segment. In this species there are some spiracles distinctly in the intersegmental membrane, each with a faint chitinous ring. The styles are peculiar in shape (fig. 273). The ãeëeagus and adjacent appendages are more complicated than in the other species studied.

In *Gymnopa tibialis* Cresson the abdomen is as usual heavily chitinized; segments one to six make up most of the abdomen; the ninth segment is rather small, the seventh and eighth greatly reduced. There are no distinct cerci. The ãeëeagus here, as in the Oscinidae studied, may be the true penis, as it is a membranous tube continuing the ejaculatory duct; the guards, probably the interior forceps, have one long spine on the inner side, as shown in figure 276.

**Family Oscinidae**

The species studied by Wesche were said by him to have apodemes of the Muscoid type. *Meromyza flavipalpis* Malloch is almost hyaline when cleared in KOH, but the strong interior forceps, apodemes and framework of the ãeëeagus are more distinct. There is a great reduction of the sixth segment and the seventh and eighth have disappeared. It is necessary to use the compound microscope to make out the membranous ãeëeagus, which is elongate and slender and may be the true penis (fig. 277). In *Chloropisca glabra* the genital segments before the ninth are merged into a peculiar striated mem-
branous structure which does not show definite sclerites. The styles are quite short and the genital framework rather narrow; the Ædeagus is comparatively large, more chitinized than in the preceding species and the double apodeme is quite slender.

Family Drosophilidae

In general there are five visible abdominal segments in the male, the first apparent segment being morphologically the first and second combined. The dorsal and lateral surfaces of the abdomen have dorso-lateral plates; the sternites become narrower posteriorly. There are two spiracles under the edge of the fused first and second segment and the next three segments have the spiracles just under the edges of the tergites in the membrane. The sixth and seventh segments are small and fused, the eighth represented by a small plate which is difficult to make out, and behind this is the genital framework or arch. On the ninth segment there are usually claspers; these may be articulated to the ninth segment or more or less free, as in Drosophila busckii; they are probably genital styles.

There are cerci on each side of the anal opening and these are always hairy, or with characteristic bristles; in some species studied by Sturtevant these cerci are connected to the ninth segment by a chitinous bridge, and according to this writer the plates of the ninth segment have the same general relation in the species of Curtonotum, Zygotherica, Pseudophortica, Scaptomyza and Drosophila. In Curtonotum helvum Loew there is an extra clasper, as in Sinophthalmus, probably the interior forceps. The Ædeagus is a chitinized tube, differing greatly in the species studied, and it can be extruded through the genital arch; the structure shows a relation to the Muscidæ. In Curtonotum the Ædeagus is long and curved as in the Trypetidæ.

In Scaptomyza terminalis Loew the abdomen is more slender than in the genus Drosophila; segments 2-6 are about equal in length, the seventh and eighth greatly reduced and modified. The sternites are small and narrow and the intersegmental membrane in the pleural region of considerable extent; the spiracles are in the membrane opposite and near the middle of the tergites. The Ædeagus is comparatively long
and the guards near the base furnished with tufts of spines (fig. 279).

In *Sinophthalmus pictus* the genitalia are like those in the preceding species in general character. There is a considerable reduction in the chitinization of the basal part of the abdomen and a remarkable reduction of the ninth segment. The eighth segment is apparently lost or fused and the seventh fused with the sixth, the line of division being visible in cleared specimens. The apodemes are well developed. The genitalia are shown in figure 278.

**Family Geomyzidae**

In *Geomyza lurida* Loew the first apparent segment is the fused first and second, there being four other large tergites in the preabdomen, and the ninth segment is large; the seventh and eighth segments are fused with other segments or are lost. The ædeagus is most unusual, parts of it being chitinized in a complex, yet symmetrical manner (fig. 280), the rest hyaline when cleared; judging from the form the ædeagus can evidently be telescoped. The interior forceps and “palpi” are not developed; the double apodeme is small and slender. The cerci are large and rather pointed.

In *Cerodontha dorsalis* Loew the sternites are very small, the number and arrangement of the segments being about as in the preceding species. In *Tethina coronata* Loew the ædeagus is very unusual; it is rather large, with a slender geniculate basal portion which is chitinized, and an apical part which is membranous, greatly enlarged, and bulbous in form; the basal portion has a dense covering of erect hairs longer than its own diameter. The cerci are rather small and membranous.

**Family Agromyzidae**

In *Agromyza cuneiventris* Fallén the abdomen is about the same as in the Geomyzidae, being composed largely of segments one to six, with the genital portion rather small. There is only one segment between the sixth and ninth, probably the eighth. The ædeagus and apodemes are well developed (fig. 282), the ædeagus being quite complex on the apical portion.
There are no separate styles on the ninth segment. The cerci are well developed.

In *Phytomyza obscurella* Fallén segments one and two are fused and segments 3-6 make up most of the rest of the abdomen. The seventh segment is apparently lost. The ãedeagus in this species is one of the most complex seen in the study of the dipterous genitalia (fig. 284), and there is an immense double apodeme for the attachment of the muscles which control this organ. In *Agromyza scutellaris puella* Meigen the ãedeagus is quite simple; the apodeme is rather long and slender and relatively smaller than in *P. obscurella*.

Mr. J. R. Malloch has recently figured the hypopygia of several species of *Leucopis* in a paper on the subfamily Ochthophilinae (Bull. Ill. Nat. Hist. Survey, vol. 13, art. 14, 1921). The genitalia possess good specific characters. The cerci are small but distinct. The ãedeagus is apparently quite variable; it is very long, chitinized and curved in *L. piniperda* Malloch, much shorter in the other species. The ninth tergite is well developed but the surstyli are small or rudimentary. *L. griseola* Fallén has the interior forceps and “palpi” well developed; the ejaculatory apodeme in this species is large and broad, not slender as in the species of *Agromyza* (fig. 283). In *L. bella* Loew the apodeme is much smaller, the ãedeagus relatively larger and shorter, with an apical slender portion differentiated from the rest; the interior forceps and “palpi” are nearly the same as in *L. griseola*. In a large undescribed species from Arizona the interior forceps, “palpi” and ãedeagus all project about the same length from the floor of the ninth segment and all are protected by the slender arms of the ninth tergite; the apodeme in this species of *Leucopis* is of the same general shape as in *L. griseola*.

**Family Milichiidae**

In this family (included by some as a subfamily in the Agromyzidae) there is not the great development and specialization of the ãedeagus seen in the Geomyzidae and Agromyzidae, if one can judge from the three species examined. *Madiza halteralis* Coquillett is heavily chitinized and the segments one to six make up most of the abdomen; the genital portion of the abdomen is extremely small, the seventh and eighth segments
greatly reduced or lost and difficult to make out in the forms studied. The whole genital portion of the abdomen is normally drawn into the sixth segment or under the sixth tergite. The outer claspers are tergal and therefore are surstyli; they are relatively large, simple, and close over the internal parts. In *M. halteralis* the ends of the styles are broad and toothed on the margin; in this same species the double apodeme is small, slender, and can be made out only under high magnification; the ædeagus is minute and there is probably an extensile membranous portion.

In *Milichia leucogaster* Loew the sternites are reduced to very narrow strips, the sixth sternal segment largest and hollowed out posteriorly; the pleural membranous area is large. The seventh and eighth segments have disappeared and the hypopygium is relatively very small. There are two long styles on the ninth tergite, the surstyli (fig. 281). On the anal segment there are two long spines, one on each of the rudimentary cerci. The double apodeme is fused with the genital arch.

*Milichiclla nitida* Hendel has much the same plan of construction as *M. leucogaster*. The sixth tergite is very large in comparison with the rest of the abdomen and the sternites are relatively larger than in the preceding species. The proctiger is different from *M. leucogaster* and lacks the two long spines. The surstyli are longer, more slender and not enlarged at the tips; the double apodeme is smaller. There are small spines near the base of the ædeagus, probably representing the interior forceps and the palpi.

**Family Hippoboscidae**

In *Olfersia americana* Leach the abdomen is largely membranous and the segments can be located by the presence of spiracles, of which there are seven pairs; one pair of spiracles is at the extreme base of the abdomen, the second pair in the chitinous base of the abdomen (the second segment), three pairs in the membranous area along the sides of the abdomen, but in a tergal position, the last two pairs in the anal region; the sixth spiracle is actually posterior to the seventh, which is moved up on the dorsum not far from the anal opening. The ædeagus, at least the intromittant organ,
which may not contain the true penis is long and sharp. The genital styles, according to my interpretation, are represented by bristly knobs and are located on each posterior corner of the genital opening. In this case the interior forceps are the long, slender, style-like appendages which point back and have a heavy framework at the base. The double apodeme is large and easily seen in cleared specimens. The anal area has a flap, bristly on the margin, and the opening of the genital organs at the tip of the abdomen is also the anal opening (cloaca).

*Lipoptena subulata* Coquillett has genitalia of the same general character as in the preceding species. The abdomen is membranous except for a poorly chitinized anal plate. In *L. mazamae* (Rondani) the ædeagus is short, scarcely projecting beyond the genital opening, the interior forceps a little longer. The framework at the base of the interior forceps reaches to the basal third of the abdomen. The styles are represented by very small chitinous areas over the interior forceps, with two long spines and two shorter ones; the interior forceps are blunt. In *L. traguli* Ferris and Cole the last five spiracles are all near the apex of the abdomen, the third pair about opposite the base of the interior forceps.

In *Melophagus ovinus* the genitalia are much the same as in *Olfersia americana*. The ædeagus is slightly longer than the interior forceps and is blunt. The spiracles are of great size, the first and second pair near the base of the abdomen, the sixth and seventh near the apex of the abdomen, below the anal opening; they are pulled around to the ventral side of the abdomen but are really tergal in location.

**Family Streblidæ**

There is less evident segmentation of the abdomen here than in the Hippoboscidæ. In *Paradyschiria fusca* Speiser the outer styles are reduced to small strips on the sides of the genital opening. The inner claspers (probably interior forceps) are long and point backwards. The ædeagus is long, slender, thick at the base and quite distinctive in shape; the apodemes are well developed. Most of the structures are internal and the specimens must be cleared to see the construction. The ejaculatory apodeme is almost as large as the double apodeme.
Family Nycteribiidæ

Wesche, in his study of the male genitalia of the Diptera, had only loan material in this family and could not dissect the specimens. In Penicillidia dufourii Westwood there is a large pair of ventral forceps, heavily chitinized and articulated at the base, probably representing the interior forceps. The ædeagus is small. There is no actual plate in the region of the laminae superiores; laterally there are two bulbous processes which are thickly spined, probably the genital styles. Wesche states that the apodemes cannot be differentiated, but a strong double apodeme is visible in cleared specimens. P. antrozoï has genitalia of the same type as the preceding species.

In Cyclopodia hopci the male has a pointed abdomen; on the ventral side there is a pair of forceps which meet at the tips, and between these are two small chitinous knobs. The segment opposite the forceps has a short row of blunt spines on the margin which may represent the laminae superiores. Nycteribia westwoodii has a like row of spines which may represent the laminae. The ædeagus is apparent in cleared specimens and the apodemes strong.

In N. biarticulata Herm. the styles and interior forceps are plainly visible, as can be seen in figure 286. The ædeagus is pointed and curved at the tip. The double apodemes are fused, the ejaculatory apodeme short and slender. In N. schmiedlii Schiner the double apodeme is long, reaching almost to the base of the abdomen. There are seven pairs of spiracles, representing as many segments; the last (and largest) segment with spiracles is the seventh; that being the case, the seventh, eighth and ninth segments are merged in one or the seventh and eighth lost.

In Eucamprisipoda sp. the outer forceps are slender and studded with short, black tubercles. In Cyclopodia ferrarii the first three spiracles are apparently in the tergites, the fourth and fifth in the membrane, the sixth and seventh in the tergites.
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EXPLANATION OF PLATES

ABBREVIATIONS.

aed...............Ædeagus or intromittant organ.
cer...............Cerci (parapodial plates in some cases).
d. apod...............Double apodeme (or sustentacular apodeme).
ds...............Dististylus (also called harpes, harpagones, etc.).
ejac. s...............Ejaculatory sac.
ej. d...............Ejaculatory duct.
ej. apod...............Ejaculatory apodeme.
gs...............Gonostipes or basal segment of genital style.
hyp...............Hypophallus.
i. f...............Interior forceps (posterior gonapophyses).
L. sty...............Left genital style.
pa...............Palpi or anterior gonapophyses.
par...............Paraphallus.
pp...............Paraprocts, or parapodial plates.
R. sty...............Right genital style.
s. or st.............Sternite.
Sa...............Subapical appendix of claspers.
Sg...............Surstyli, or surgonopods.
sh...............Sheath of ædeagus.
s. l...............Superior laminae.
sp...............Spinus titillatorius.
t...............Tergite.

Roman numerals are used to indicate the number of the urite, whether tergite or sternite.
2. *Bruchomyia argentina* Alex., aedeagus and genital framework.
3. *Bruchomyia argentina* Alex., lateral view of external genitalia.
4. *Tipula simplex* Doane, ventral view of terminal structures.
5. *Tipula tristis* Doane, internal genitalia, part of left side cut away.
6. *Nephrotoma californica* Doane, terminal structures as they appear with body wall cut away on right side.
7. *Tipula derby* Doane, lateral view of terminal structures.
10. *Nephrotoma californica* (Doane), lateral view of entire abdomen.
11. *Bittacomorphella sackeni* (Röder), dorsal view of terminal structures, segments in front of ninth cut away to show the large ejaculatory sac.


15. *Trichocera* sp., ventral view of terminal structures.


17. *Bittacomorpha clavipes* (Fabr.), lateral view of terminal structures of abdomen.


24. *Psychoda* sp., view showing upper claspers of genitalia.
25. *Psychoda* sp., lateral view of terminal claspers.
31. *Anopheles punctipennis* (Say), ventral view of terminal structures.
32. *Orphnephila testacea* (Ruthe), dorsal view of terminal structures.
33. *Orphnephila testacea* (Ruthe), aedeagus and appendages.
34. *Mycetobia divergens* Walk., ventral view of terminal structures.
35. *Sciophila calceata* Coq., lateral view of terminal structures.
36. *Symmerus* sp., lateral view of terminal structures.
37. *Symmerus* sp., ventral view of ninth sternite.
38. *Boletophila hybrida* (Meig.), dorso-lateral view of terminal portion of abdomen.


42. *Mycetophila punctata* Meig., lateral view of genitalia.


44. *Cecidomyia resinicoloides* Will., Dorsal view.

45. *Cecidomyia resinicoloides* Will., ventral view.

46. *Reichertellia collaris* Mel., ventral view of terminal structures.

47. *Scatopse notata* (Linn.), ventral view of genitalia.

48. *Scatopse notata* (Linn.), ejaculatory sac and appendages.

49. *Bibio hirtus* Loew., ventral view of terminal structures.


51. *Bibio nervosus* Loew., ãedeagus and appendages.

52. *Rhegmoclema atrata* (Say), ventral view of terminal structures.

53. *Rhegmoclema atrata* (Say), ãedeagus and adjacent structures.


55. *Plecia ruficollis* Fabr., dorsal view of terminal structures.
56. *Simulium ornatum* Meig., ventral view of terminal structures (re-drawn from Edwards' figure).

57. *Prosimulium hirtum* (Fries), ventral view of terminal structures.

58. *Simulium pictipes* Hagen, ventral view of terminal structures.

59. *Simulium pictipes* Hagen, ventral view of terminal structures.

60. *Bibiocephala grandis* O.S., ædeagus and adjacent structures.

61. *Hapalothrix lugubris* Loew, lateral view of terminal structures.

62. *Beres annulifera* (Big.), lateral view of terminal structures.

63. *Sargus viridis* Say, dorsal view of terminal structures.

64. *Odontomyia hoodiana* Big., dorsal view of terminal structures.

65. *Odontomyia hoodiana* Big., ventral view.


68. *Stratiomyia maculosa* Loew, dorsal view of terminal structures.


70. *Ptecticus trivittatus* Say, lateral view of abdomen.

72. *Chrysops noctifer* O.S., ventral view of terminal structures.

73. *Tabanus punctifer* O.S., ventral view of terminal structures.

74. *Symphoromyia cruenta* Coq., ventral view of terminal structures.

75. *Xylomyia pallipes* (Loew), lateral view of terminal structures.

76. *Leptis incisa* Loew, ventral of terminal structures.

77. *Pantophthalmus versicolor* Aust., ventral view.


80. *Ocodes costatus* Loew, ventral view of abdomen.


82. *Ocodes costatus* Loew, genitalia dissected out, showing the ædeagus and apodemes.
83. *Opsebius diligens* O.S., genitalia and ninth tergite.

84. *Eulonchus sapphirinus* O.S., lateral view of terminal structures.

85. *Bombylius major* Linn., ventral view of terminal structures.

86. *Eulonchus tristis* Loew, lateral view of terminal structures with separate drawing of ædeagus and appendages.

87. *Opsebius diligens* O.S., lateral view of terminal structures.

88. *Heterostylum robustum* O.S., lateral view of genitalia, the tenth tergite removed.

89. *Villa lateralis* (Say), lateral view of terminal structures.

90. *Ogcodes albicincta* Cole, ventral view of terminal structures.

91. *Bombylius major* Linn., lateral view of terminal structures.

92. *Bombylius major* Linn., ventral view of terminal structures.

93. *Thereva vialis* O.S., genitalia, the ninth tergite and right side of sternite removed.

94. *Exoprosopa caliptera* (Say), lateral view of terminal structures.

95. *Spogostylum adipus* (Fabr.), lateral view of terminal structures.

96. *Dialineura crassicornis* (Will.), ædeagus and claspers of left side.
98. *Psilocephala hamorrhoidalis* (Macq.), aedeagus and apodemes.
100. *Scenopinus fenestralis* Linn., aedeagus and adjacent structures.
102. *Psilocephala hamorrhoidalis* (Macq.), genitalia, the ninth tergite removed.
103. *Dialineura crassicornis* (Will.), ventral view of terminal portion of abdomen.
105. *Apiocera haruspex* O.S., lateral view of terminal structures.
106. *Apiocera haruspex* O.S., genitalia dissected out.
107. *Apiocera haruspex* O.S., lateral view of genitalia.
109. *Cyrtopogon prapes* Loew, aedeagus and adjacent structures, a part of one side of ninth segment removed.
110. *Dasyllis grossa* Fabr., lateral view of terminal structures.
111. *Promachus vertebraurus* Say, lateral view of terminal structures.
112. *Dasyllis californicus* Banks, aedeagus and apodemes.
113. *Dasyllis californicus* Banks, showing structures guarding the aedeagus.
114. *Dasyllis californicus* Banks, dististylus and appendages.
115. *Dasyllis californicus* Banks, dorsal view of terminal portion of abdomen.
118. *Asilus occidentalis* Hine, aedeagus and claspers.
119. *Lasiopogon arenicola* O.S., under side of cerci.
120. *Lasiopogon arenicola* O.S., lateral view of aedeagus.
121. *Erax barbatus* Fabr., genitalia, tergite and one side removed.
122. *Asilus occidentalis* Hine, lateral view of terminal structures.
123. *Dasyllis californicus* Banks, showing aedeagus and inner side of ninth tergite.
125. *Lasiopogon arenicola* O.S., ventral view of genitalia.
126. Scellus monstruosus O.S., lateral view of terminal portion of abdomen, showing remarkable modification of fifth segment.

127. Scellus monstruosus O.S., ventral view of segments IV-VII.

128. Liancalus similis Aldr., lateral view of terminal portion of abdomen.

129. Liancalus similis Aldr., lateral view, showing right side of terminal segments (smaller magnification).

130. Dolichopus plumosus Aldr., lateral view of terminal structures.

131. Dolichopus plumosus Aldr., under side of cerci.

132. Dolichopus plumosus Aldr., Genitalia, right side removed.

133. Apiocheta sp., lateral view of hypopygium.

134. Apiocheta rufipes Meig.

135. Phora velutina Meig., lateral view of hypopygium.

137. *Rhamphomyia* sp., no. 2, lateral view of hypopygium.
138. *Rhamphomyia* sp., no. 1, lateral view of genitalia.
139. *Empis aldrichi* Mel., lateral view of genitalia.
140. *Empis aldrichi* Mel., lateral view of terminal structures.
142. *Platypeza velutina* Loew, lateral view of hypopygium.
143. *Platypeza velutina* Loew, ædeagus and guards.
144. *Lonchoptera* sp., lateral view, apical segments of abdomen.
145. *Platypeza agarici* Williard, lateral view of hypopygium, with separate figure showing proctiger from above.
146. *Chalarus spurius* (Fall), ventral view of genitalia.
147. *Pipunculus* sp., no 1, ædeagus and guards.
148. *Chalarus spurius* (Fall), genitalia, ninth tergite removed.
149. *Pipunculus* sp., no. 1, ædeagus and attachments.
150. *Chalarus spurius* (Fall), ædeagus and apodemes, greatly enlarged.
151. *Pipunculus* sp. no. 1, showing right side of abdomen and portion of venter.
152. *Pipunculus* sp. no. 1, showing dorsum and part of left side of the abdomen.
153. *Pipunculus* sp. no. 2, ædeagus and apodemes, greatly enlarged.
155. *Arctophila flagrans* O.S., ventral view of hypopygium.
156. *Volucella esuriens* (Fabr.), ædeagus and apodemes.
158. *Mesogramma geminata* (Say), ventral view of abdomen.
159. *Mesogramma geminata* (Say), genitalia, lateral view.
160. *Lasioptthicus pyrastrii* (Linn.), ædeagus and apodemes; ninth tergite and cerci.
162. *Caliprobola pulcher* (Will.), ædeagus and appendages.
163. *Eristalis tenax* (Linn.), ventral view of genitalia.
164. *Eristalis vinetorum* (Fabr.), ædeagus and appendages.
165. *Melanostoma obscurum* (Say), lateral view of genitalia.
166. *Paragus bicolor* (Fabr.), dorsal view of abdomen.
167. *Paragus bicolor* (Fabr.), lateral view of genitalia.
171. *Gastrophilus intestinalis* De Geer, lateral view of genitalia.
172. *Myopa seminuda* Banks, ventral view of terminal segments of abdomen.
174. *Cuterebra americana* (Fabr.), lateral view of ædeagus and adjacent structures.
175. *Myopa seminuda* Banks, ædeagus and apodemes.
177. *Cuterebra americana* (Fabr.), ventral view of terminal abdominal segments.
179. *Hypoderma lineata* (De Vill.), ventral view of genitalia.
182. *Blepharippeza adusta* Loew, lateral view of genitalia.
183. *Peleteria tesselata* (Fabr.), lateral view of genitalia.
185. *Paradejeania rutiloides* (Jeann.), ventral view of hypopygium.
188. *Gymnosoma fuliginosa* Desv., ventral view of genitalia.
192. *Myiocera tibialis* (Desv.), lateral view of genitalia.
195. *Graphomyia maculata* (Scop.), ventral view of genitalia.
196. *Graphomyia maculata* (Scop.), lateral view of aedeagus and adjacent structures.
198. *Sarcophaga sp.*, lateral view of hypopygium.
199. *Sarcophaga communis* Parker, lateral view of genitalia.
201. *Phormia regina* (Meig.), lateral view of genitalia.
202. *Phormia regina* (Meig.), ventral view of genitalia (smaller magnification than fig. 201).
203. *Phormia regina* (Meig.), aedeagus and structures at base.
204. *Myiospila meditubunda* (Fabr.), lateral view of terminal segments of abdomen.
205. *Cynomyia cadaverina* Desv., genitalia viewed from below and on left side.
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207. *Musca domestica* Linn., ædeagus and structures at base, greatly enlarged.

208. *Musca domestica* Linn., ventral view of hypopygium, showing membranous anal portion.


210. *Cochliomyia macellaria* (Fabr.), lateral view of genitalia.

211. *Pollenia rudis* (Fabr.), lateral view of genitalia.

212. *Hylemyia alcathoe* (Walk.), ventral view of abdomen.

213. *Hylemyia alcathoe* (Walk.), lateral view of hypopygium.


216. *Scatophaga stercoraria* (Linn.), ninth tergite and cerci.

217. *Scatophaga stercoraria* (Linn.), ædeagus and adjacent structures.

218. *Scatophaga furcata* (Say), ædeagus, apodemes, etc.

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220. _Clusia lateralis_ Walk., ventral view of genitalia.
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222. _Leria serrata_ (Linn.), lateral view of hypopygium.
223. _Helomyza limbata_ Thoms., ventral view of apical half of abdomen.
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227. _Leria crassipes_ Loew, lateral view of hypopygium.
228. _Anorostoma grandis_ Darl., lateral view of apical portion of abdomen.
229. _Calopa frigida_ Fall., lateral view of abdomen.
230. _Copromyza equina_ Fall., ventral view of ædeagus and structures on right side.
231. _Leria crassipes_ Loew, ædeagus and structures at its base.
232. _Copromyza equina_ Fall., dorsal view of tip of abdomen.
233. _Copromyza equina_ Fall., ventral view of tip of abdomen.
234. _Leptocera atra_ Adams, ædeagus and apodemes.


238. *Dictya umbrarum* (Linn.), aedeagus and adjacent structures.

239. *Rhopalomera femorata* (Fabr.), fifth, sixth, and seventh sternites.

240. *Rhopalomera femorata* (Fabr.), lateral view of hypopygium.


242. *Sapromyza* sp., dorsal view of structures connected with aedeagus.

243. *Lonchea polita* Say, aedeagus, apodemes, etc.

244. *Palloptera terminalis* Loew, lateral view of genitalia, showing remarkable aedeagus and apodemes.

245. *Chrysomyza demandata* (Fabr.), aedeagus.

246. *Chrysomyza demandata* (Fabr.), genitalia, showing base of the aedeagus.

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249. *Tetanops aldrichi* Hendel, lateral view of genitalia, showing only base of ædeagus.

250. *Tetanops aldrichi* Hendel, ventral view of tip of abdomen.

251. *Richardia podagrica* (Fabr.), lateral view of hypopygium.


254. *Anastrepha ludens* (Loew), lateral view of proctiger and ninth tergite.


259. *Calobata alesia* Walk., abdomen boiled in KOH, with the genitalia and body segments stretched out.
260. *Calobata antennipes* Say, lateral view of abdomen.
265. *Diapsis subnotata* Westw., ventral view of genitalia, portion of left side cut away.
266. *Diapsis subnotata* Westw., ninth tergite.
268. *Sphyracephala brevicornis* Say, ventral view of genitalia, a part of left side cut away.
269. *Chyliza leguminicola* Mel., ventral view of genitalia.
270. *Chyliza robusta* Coq., ventral view of genitalia (ædeagus and adjacent structures.
271. *Parydra bituberculata* Loew, ædeagus and appendages of one side.
273. *Ochthera mantis* (De Geer), ninth tergite and cerci.
274. *Ephydra millbrae* Jones, latero-ventral view of abdomen.
275. *Ochthera mantis* (De Geer), ventral view of genitalia.
278. *Sinophthalmus pictus* Coq., lateral view of hypopygium.
279. *Scaptomyza terminalis* Loew, lateral view of hypopygium.
280. *Geomyza lurida* (Loew), lateral view of abdomen.
282. *Agromyza anecventris* Fall., ædeagus and appendages.
283. *Leucoptes griseola* Fall., lateral view of genitalia.
284. *Phytomyza obscurella* Fall., ædeagus and appendages.
286. *Nycteribia biarticulata* (Herm.), ventral view of genitalia.
287. *Olfersia americana* (Leach), ventral view of genitalia.
XV

NEW GENERA AND SPECIES OF NORTH AMERICAN FISHES

BY

DAVID STARR JORDAN

AND

BARTON WARREN EVERMANN

In the preparation of a revised Check-List of the Fishes of North and Middle America upon which the present writers have been engaged for a number of years (and which is now about ready to send to the printer), it was found necessary to establish several new genera, subgenera, and species, and to provide new names in a few cases where the current names were discovered to be preoccupied.

It seems best to publish all these in advance of their appearance in the Check-List, which we now do in this paper.

1. **Anchoa** Jordan & Evermann, new subgenus of Engraulidæ

   *Type*: *Engraulis compressus* Girard.

   Distinguished from *Anchoviella* by a much greater number of gillrakers, there being 35 to 50, while in *Anchoviella* there are only 25 to 40; anal rays 30 or more; body deeper.

   These characters indicate a transition toward *Anchovia*.

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2. **Hildebrandia** Jordan & Evermann, new genus of Congridæ

*Type:* *Congermurana flava* Goode & Bean.

This genus is well distinguished from *Ariosoma* and *Anago* by the long snout, the projecting lower jaw, the very long tail, and the anterior insertion of the dorsal,—far in advance of the gill-opening. The mouth is small and the teeth are in narrow bands.

The genus is named for Dr. Samuel F. Hildebrand, joint author with the late Dr. Seth Eugene Meek of excellent treatises on the "Marine Fishes of Panama" and on the "Fishes of the Freshwaters of Panama."

3. **Clarkina** Jordan & Evermann, new genus of Cyprinidæ

*Type:* *Cyprinus caurinus* Richardson.

This genus differs from *Richardsonius* in the shorter anal fin in which there are only 9 rays. The body is elongate and covered with very small scales of which there are 86 in the lateral line.

It is named for our associate, Howard Walton Clark, Assistant Curator of Fishes, California Academy of Sciences.

4. **Hudsonius aletes** Jordan & Evermann, new species

This species is close to *Hudsonius heterodon*, but differs in the complete lateral line and in having the teeth 2, 4 - 4, 2.

It is based upon specimens collected in Switz City Swamp, Greene County, Indiana, by Dr. Charles H. Gilbert and recorded by him as *Notropis heterodon* in Proc. U. S. Nat. Mus., VII, 1884, 207.

5. **Girardinichthys limnurgus** Jordan & Evermann, new species

This species is related to *G. innominatus* Bleeker, but differs from that species in having more fin-rays, there being 23 in

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the dorsal and 26 in the anal. We base this species upon specimens from Lake Lerma, Mexico, identified as *G. innominatus* Bleeker, by Evermann & Goldsborough, Bull. U. S. Fish Com., XXI, 1901 (1902), 149.

*Type:* No. 50229, U. S. Nat. Mus., a specimen 40 mm. long, collected in 1901, by Dr. J. N. Rose, in **Lake Lerma, Mexico**.

6. **Forbesella** Jordan & Evermann, new genus of Amblyopsidæ

*Type:* *Chologaster papilliferus* Forbes.

This genus stands between the original type of *Chologaster (C. cornutus)*, well colored and with developed eyes, and the colorless blind fishes of the genera *Amblyopsis* of the caves of the central Mississippi Valley.

From *Chologaster* this genus differs in the presence of tactile papillae, as in *Amblyopsis*.

We take great pleasure in naming this new genus for our life-long friend and co-worker on the fishes of the Mississippi Valley, Dr. Stephen Alfred Forbes of the University of Illinois, and discoverer of the type species.

7. **Hyporhamphus hildebrandi** Jordan & Evermann, new species


This species is based upon specimens obtained by Meek and Hildebrand at Toro Point, Fox Bay, Colon, and identified by them with *Hemirhamphus roberti* Cuv. & Val., 1846, the type of which came from Cayenne and which is certainly identical with *Hemirhamphus unifasciatus* Ranzani, 1842, the type of which came from Brazil. These two nominal species appear to be identical, but the Fox Bay specimens seem to differ in some respects, chiefly in the greater number of gillrakers of which there are 28 to 31, while in *H. unifasciatus* there are
only 20 to 24.\(^3\) Type: No. ?; Field Museum Nat. Hist., a specimen collected by Meek and Hildebrand at Toro Point, Fox Bay, Colon.

8. **Gladiunculus** Jordan & Evermann, new subgenus of Gasterostidae

_Type:_ *Gasterosteus gladiunculus* Kendall = *G. bispinosus* Walbaum, fide Kendall.

This subgenus is characterized by the presence of a lobe at the base of the ventral spine, the absence of serrations on the ventral spine, and the incomplete armature, as recently shown by Dr. William Converse Kendall, who has made clear the characters and the synonymy of *Gasterosteus bispinosus*.

9. **Syrichtes** Jordan & Evermann, new genus of Syngnathidae

_Type:_ *Syngnathus fuscus* Storer.

This subgenus includes those species of *Syngnathus* (typified by *Syngnathus fuscus* Storer) which have the vent notably behind the most of the dorsal fin, the rays before it being usually 4 or 5, rarely 3. The species of *Syrichtes*, so far as known, are confined to the Atlantic and Gulf coasts of the United States. All the species of *Syngnathus* examined, including *Syngnathus acus* from the Mediterranean and *S. schlegeli* from Japan, have the first ray of the dorsal fin nearly over the vent. \(\sigmaυπικτης\), a piper.)

10. **Ptax** Jordan & Evermann, new genus of Gempylidae

_Type:_ *Dicrotus parvipinnis* Bean.

This genus is characterized by the number of fin-rays; D. XXI, 11; A. II, 8; the number in *Promethichthys* being D. XVIII, 19-II; A. II, 16.

The name *Ptax* is from \(\piτεξ\), a hare, conejo; a Spanish name of the related *Promethichthys prometheus*.

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\(^3\) This view has been confirmed by Dr. Jacques Pellegin, who examined the types in Paris.
11. Xurel Jordan & Evermann, new genus of Carangidæ

*Type:* *Caranx vinctus* Jordan & Gilbert.

This genus is close to *Caranx* from which it is distinguished by the high sheath of scales at the base of the dorsal fin, by the low anterior lobe of the dorsal and anal, and by the short, highly arched lateral line. Breast scaly; gillrakers very long and numerous, the last small and blunt.

*Xurel* (Latin, Saurus), a Cuban name of certain Carangidæ.

12. Carangulus Jordan & Evermann, new subgenus of Carangidæ

*Type:* *Caranx latus* Agassiz.

This subgenus differs from *Caranx* Lacépède (*Scomber hippos* L.) in having the breast and thoracic region entirely scaled. In *Caranx* proper this region is naked except for a small rhombic patch of scales before the ventrals.

13. Vivero Jordan & Evermann, new subgenus of *Epinephelus*

*Type:* *Epinephelus morio* (Cuv. & Val.) which differs from all other species of *Epinephelus* in the greater length of the second dorsal spine.

14. Haemulon mowbrayi Jordan & Evermann, new name

Substitute for *Haemulon chrysopterum* Mowbray, preoccupied by *Haemulon chrysopterum* Cuv. & Val.—(*Haemulon chrysopterum* Günther).

15. **Kyphosus metzelaari** Jordan & Evermann, new species

*Type locality:* **Curacao, Venezuela.**

This species is very close to *Kyphosus elegans* of the Pacific, but, according to Metzelaar, the scales are larger, there being 52 in the lateral line while there are 63 in *elegans*. The teeth are also fewer, “15 in the upper jaw,” while in *elegans* there are “36 in each jaw.”

16. **Eugerres** Jordan & Evermann, new genus of Gerridae

*Type:* **Gerres plumieri** Cuvier & Valenciennes.

This genus is based upon the section Gerres in Jordan & Evermann, Fishes North and Middle America, 1374, 1898, containing *G. lineatus, plumieri*, etc., and is characterized by the serrate preorbital and the very strong dorsal and anal spines.

17. **Vacuoqua** Jordan & Evermann, new genus of Scisniidæ

*Type:* **Corvina macrops** Steindachner.

This genus differs from the aberrant *Corvula batabana* (type of *Carvula*) in having a deeper, symmetrical body and the silvery coloration of *Bairdiella* and related species.

18. **Eriscion** Jordan & Evermann, new subgenus of Cynoscion (Scisniidæ)

*Type:* **Cynoscion nebulosus** Cuv. & Val.

This differs from typical *Cynoscion* in having the dorsal and anal fins scaleless.

19. **Sebastopyr** Jordan & Evermann, new genus of Scorpaenidæ

*Type:* **Sebastodes ruberrimus** (Cramer).

This genus is allied to *Sebastomus*, but of much coarser build, the cranial spines in the adult being rough with blunt spinules.
20. **Sebastocarus** Jordan & Evermann, new genus of Scorpenidae

*Type:* *Sebastichthys serriceps* Jordan & Gilbert.

This genus is closely allied to *Sebastichthys* from which it differs in the more compressed body and especially in the strict and high ridges on the head, all of them being free from serrations or accessory tubercles.

21. **Theraps terrabæ** Jordan & Evermann, new name

*Type locality:* Buenos Aires de Terraba, Costa Rica.

XVI
A GEOLOGIC SECTION IN THE CENTER OF THE SAN JOAQUIN VALLEY, CALIFORNIA*

BY

J. A. TAFF & G. D. HANNA
Associated and Pacific Oil Companies

During 1925 the Associated and Pacific Oil Companies drilled three deep test wells in the flat plain of San Joaquin Valley, where the sequence of strata has long been more or less a matter of general speculation. The wells and their locations are as follows:

<table>
<thead>
<tr>
<th>WELL NO.</th>
<th>LOCATION</th>
<th>DEPTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sec. 26, T. 15, R. 18 (13 miles S. W. of Fresno)</td>
<td>6042'</td>
</tr>
<tr>
<td>1</td>
<td>Sec. 14, T. 15, R. 18 (12 miles S. W. of Fresno)</td>
<td>6884'</td>
</tr>
<tr>
<td>1</td>
<td>Sec. 35, T. 13, R. 16 (23 miles west of Fresno)</td>
<td>5737'</td>
</tr>
</tbody>
</table>

Careful records were kept throughout the drilling; rotary equipment and efficient core-barrels were the means whereby a very large number of uncontaminated samples of formations were obtained. A study of these samples has enabled us to reconstruct the section with as great, and probably greater accuracy than if it had to be made from surface exposures.

* This paper was read before the Berkeley, California, meeting of the Le Conte Geological Club on October 16, 1925.

April 27, 1927
Some difference in sequence was found in the three localities. For instance, the Santa Margarita Miocene was found in the well on Section 35 at 3267-3275 feet; on Section 14, at 3954-3963 feet; on Section 26 at 4352 feet. This and later data show that there is a progressive rising of the strata to the northward, which has no indication on the surface.

The formation known as "Big Blue" on the west side of the valley, was identified in all three wells. On Section 26, it was 600 feet thick; on Section 14, 850 feet thick; and on Section 35, 762 feet thick.

The lower part of the Miocene differed very much in the well on Section 35, from the other two by having strata, aggregating 200 feet which contained organic shales; this condition was not found in the wells on Sections 14 and 26, and it is very improbable that it could have been present and missed, considering the thoroughness with which the coring was done. This again illustrates the elusiveness of bedded sands and shales in valley Miocene.

Definite Eocene rocks were struck in all three wells, and the upper contact has been placed at 4973 feet on Section 35; at 5619 feet on Section 14; and at 5658 feet on Section 26. None of the wells passed out of this formation.

Details of the sections in each well follow:

*Well No. 1, Sec. 26, T. 15 S., R. 18 E., M. D. M.*

Fine-grained shales, sandy shale and coarse sand, gray to brown in color and without organisms were found, from the surface to 4352 feet. At 4226 feet some fragmentary Mollusca were found which were thought to be Etchegoin in age.

At 4352 feet definite Santa Margarita strata were encountered, which contained distinctive pectens, oysters and barnacles. The formation consisted in the main of medium grained sands with only occasional layers of non-fossiliferous shale.

At 4691 feet there was entered a zone of dark blue to green, fine-grained clay shale, occasionally becoming a tough chocolate-brown, massive, clay shale. Sometimes these two colors were curiously mixed in the bedding. The material was proba-
bly derived from erosion of land areas of serpentine. No fossils were found in it except near the base in this well where a few imperfect impressions of diatoms were seen. The formation so agrees in lithology and position with what has been called “Big Blue” in the Coalinga region that we felt safe in making that correlation. Toward the base the formation became more and more sandy.

At 5292 feet a fine grained gray sandstone was struck. Some succeeding layers were of unconsolidated sand, varying in coarseness and consolidation from place to place, and at 5480 feet there was definite conglomerate.

This 200 feet of decidedly arenaceous sediments was succeeded at 5508 feet by clay shales again. The color of these was various shades of blue, green and brown, sometimes variegated in the same sample. Fossils were practically absent.

At 5658 feet there was a decided change in the sedimentation. Greenish gray, coarse grained sandstone, with numerous imperfect remains of what appeared to be fossil algae was found. This indicated lagoon conditions so prevalent in the Eocene that we were convinced here was the beginning of rocks of this age. This determination was corroborated at 5770 feet by the finding of some corals which appeared to belong to a common Eocene species. At this depth and below, there was much tan and buff colored clay shale. It continued with few interruptions to the bottom of the well, at 6042 feet. Some of this shale, and possibly a great deal, was in the nature of tuff, but did not appear to have been laid down on land. Dips which appeared to be reliable were found as steep as 20°. Above the Eocene the strata were practically horizontal.

A recapitulation of the section of this well is as follows:

Alluvium, Tulare and Etchegoin Pliocene formations from the surface to 4352’;
Santa Margarita Miocene from 4352’ to 4691’;
“Big Blue” Miocene from 4691’ to 5292’;
Probably Vaqueros sands from 5292’ to 5508’;
Undifferentiated clay shales from 5508’ to 5658’;
Eocene sands and shales 5658’ to 6042’.
Associated Oil Company

Well No. 1, Sec. 14, T. 15 S., R. 18 E., M. D. M.

This well offsets one which is known as Fresno United No. 2, drilled by the Fresno United Oil Company, and in which there was found at about 4000 feet definite Santa Margarita Mollusca.

The Associated well was carefully cored and reached the depth of 6857 feet. Bit and ditch samples were collected from a depth of 350 feet to 3534 feet, and, while they were non-fossiliferous, they resembled so closely material from the Tulare and Etchegoin elsewhere in the San Joaquin Valley that such classification was considered reliable. A line of demarcation between the two could not be definitely drawn.

Fine and coarse grained sandstone, sometimes poorly consolidated, was found from 3810 to 3963 feet, where the first fossils were encountered. These were barnacles and oysters of unquestionable Santa Margarita age.

From 3963 feet the color of the sandstones varied from blue and brown to gray; at 4135 and 4248 feet, there were numerous fossil leaves and at 4210 feet a piece of a crab. The last Santa Margarita fossils were found at 4353 feet.

From 4353 to 5206 feet the sediments consisted chiefly of blue, green and brown fine-grained clay shales, with occasionally some layers of sand, especially in the lower part. Some of the cores had vari-colored clays in one sample. They appeared to have been derived from erosion of serpentine land areas and the whole formation was considered to be "Big Blue."

At 5206 feet a conglomerate was found, some of the igneous pebbles of which were one-and-one-half inches in diameter. Vari-colored sands and sandy shales continued downward to 5338 feet.

From 5349 to 5555 feet there was a continuous bed of greenish gray and brown shale, sometimes variegated in the same sample.

At 5555 to 5581 feet there was conglomerate with pebbles up to one inch in diameter. The pebbles were composed of various metamorphic and igneous rocks. Various sands and sandy shales continued to 5670 feet.
At 5670 feet there appeared a coarse grained, buff colored sandstone; buff and tan sands, interbedded with greenish and brownish clay shales continued downward to 6332 feet.  

At 6360 feet there appeared a hard dark brown, thinly laminated shale, with numerous foraminifera of definite Eocene age. The dip changed between these two formations from about 10° to about 25°, indicating a decided angular unconformity.  

Glaucnolite and Eocene fish scales were found at 6500 feet where the dip became about 45°. This layer of shale continued downward to 6604 feet. At 6634 feet there was a dark olive gray shale which at 6673 feet had definite Eocene Mollusca.  

Dark gray sandstones and sandy shales and clay shales continued from 6634 feet to the bottom of the well at 6884 feet.  

A recapitulation of the section of this well is as follows:  

Alluvium, Tulare and Etchegoin Pliocene from the surface down to 3963';  

Santa Margarita Miocene, 3963' to 4353';  

"Big Blue" Miocene, 4353' to 5206';  

Vaqueros? sands, 5206' to 5338';  

Undifferentiated clay shales, 5349' to 5555';  

Undifferentiated conglomerates and sands probably the base of the Miocene, 5555' to 5670';  

Undifferentiated sands and clays, probably Eocene, 5670' to 6332';  

Thinly bedded, tough, foraminiferal Eocene shales, 6360' to 6604';  

Eocene sands, 6634' to 6884'.  

Associated Oil Co.  

Well No. 1, Sec. 35, T. 13 S., R. 16 E., M. D. M. (Herminghaus)  

Bit and core samples were taken in this well from 1837 to 3162 feet the material passed through being various kinds of shale and sandy shale of probably Tulare age. This was followed by about 50 feet of gray sands which may have been Etchegoin.  

At 3267 feet the first fossils were found, and these proved to be Santa Margarita oysters. Coarse grained sandstone
continued down to 3520 feet. It was followed at 3538 feet by a diatomaceous clay shale, which continued to 3552 feet. This shale was unquestionably Miocene in age.

At 3588 feet gray sandstones began, which continued interrupted only by sandy shales and clay shales of the same color, to 3967 feet.

The "Big Blue" began at 3992 feet and as usual was composed of massively bedded green, blue and brown clay shales, sometimes variegated in the same sample. At 4217 to 4225 feet, an interbedded olive gray clay shale continued to 4744 feet.

From 4772 to 4973 feet there was found a deposit of very organic, dark brown, thinly bedded shale. Diatoms, foraminifera and fish remains were abundant. A petroleum residue was found in these samples. The organisms contained in this deposit were of Miocene age, and it is believed to be the equivalent of the diatomaceous shale north of Coalinga, below the Vaqueros Reef and above the Eocene sands. This usually goes under the name of "Kreyenhagen Shale," but appears to be an integral part of the Miocene and certainly not the same as the Kreyenhagen Shale at the type locality on Canoas Creek; this latter is Eocene. In none of the Miocene strata outlined above was a dip of more than 5° found.

At 4981 feet a gray sandstone was struck, evidently the top of the Eocene. At 5014 feet a common Eocene Turritella and numerous Foraminifera and Mollusca were found in a greenish gray sandy shale. Much glauconite existed in this immediate vicinity and the texture of the rocks was very similar to the outcrops of Eocene shales in Marysville Buttes. Very fossiliferous strata continued downward, there being numerous layers with much carbonized wood and other plant remains. The last sample came from 5737 feet and showed no indication of a change in formation.

A recapitulation of the section of this well is as follows:

Alluvium, Tulare and Etchegoin Pliocene from surface down to 3235’;
Santa Margarita Miocene, 3267' to 3520';
Miocene Shale, 3538' to 3552';
Undifferentiated Miocene sands, 3588' to 3967';
"Big Blue" Miocene, 3992' to 4744';
Lower Miocene diatomaceous shales, 4772' to 4973';
Eocene sands, sandy shales and clay shales, 4981' to 5737'.

After the foregoing report was in proof a fourth well was completed in this general region. It was Associated Oil Company Well No. 1, Sec. 36, T. 13 S., R. 16 E., M. D. M., (Herminghaus) and about half a mile northeast of the one last considered above. Excellent confirmation of the geologic section was obtained. Lower Miocene diatomaceous shales were found from 4790' to 5024', after which Eocene sands and shales with many characteristic fossils were found to the bottom of the well at 5078'.

It will be noted from the above that the siliceous shales just above the Eocene have been called "lower Miocene." This is done because they have not been definitely identified with the formation on the west side of the San Joaquin Valley mapped as "Kreyenhagen" by Anderson and Pack¹ and questionably referred by them to the "Oligocene."

XVII

A REVISION OF THE GENUS ORTHOCARPUS

BY

DAVID D. KECK

INTRODUCTION

The studies on which this paper is based were carried on in the herbarium at Pomona College under the direction of Dr. Philip A. Munz to whom I am indebted for generous help and suggestions. In addition to the specimens in the Pomona College Herbarium (Po), there was available material from the Gray Herbarium (G), Rocky Mountain Herbarium (RM), State College of Washington Herbarium (WS) and the Herbarium of Willamette University.

After the work at Pomona College was completed there was opportunity to make those additions and corrections found advisable after a study of the material in the Herbarium of the California Academy of Sciences (CA), Herbarium of the University of California (UC), and the Dudley Herbarium of Stanford University (St). Miss Alice Eastwood, of the California Academy of Sciences, kindly loaned me her valuable notes on this genus and Dr. H. M. Hall, of the Carnegie Institution of Washington, gave various helpful suggestions and criticisms. Several other botanists have kindly sent specimens or valuable notes which have been of much aid in this study. To all of these I wish to express my appreciation. Particular
thanks are due to the curators of each of the above mentioned herbariums for the privilege of examining or borrowing material. The abbreviations indicated in the above parentheses are those used in citing specimens. In most cases only a part of the collections studied have been cited.

Relationships between Orthocarpus and allied Genera

In revising the genus Orthocarpus it was found that two major divisions have been recognized. The annuals constitute one definite group and include most of the described species. The longer-lived ones make up the other division. Several apparently distinct species have been described in this latter group most of which have been referred at one time or another to Castilleja. These I propose to incorporate in Castilleja because of their evident relationship. A gradual series can be arranged, leading from *O. pilosus* Wats., and *O. pallescens* Gray, two species most persistently grouped with the genus Orthocarpus, through *O. psittacinus* Eastw., *C. longis-pica* Nels., *C. ambigua* Jones, etc., to undoubted species of Castilleja, whereas there is an abrupt break between any of these and the other species of Orthocarpus. *Orthocarpus pallescens* Gray, has a moderately large, somewhat saccate lower lip, exceeded by the galea by about 3 mm. in which respects it resembles Orthocarpus, but in its calyx with two bifid lobes and in its perennial habit it is like Castilleja. It has been transferred to Castilleja by Greenman. *Orthocarpus parryi* Gray, is a synonym. *Orthocarpus pilosus* Wats., transferred to Castilleja by Rydberg, has the characteristic calyx and corolla of Orthocarpus except that the lower lip is very shallow. Its habit is like Castilleja. *Castilleja ambigua* Jones, appears very similar to *O. pallescens* but is more clearly a Castilleja because of the wide galea, flat lower lip and the long calyx which nearly equals the corolla. *Orthocarpus psittacinus* Eastw., belongs here and should be referred to Castilleja for the flat lower lip with three long teeth is a characteristic of this group. It is close to *O. pilosus*. The calyx is 4-cleft into subequal lobes in which respect it resembles Orthocarpus. Apparently on account of this calyx character Jepson has placed
C. cinerea Gray, and C. schizotricha Greenm., in Orthocarpus. The floral characters and habit label these positively as Castillejas, especially C. cinerea, which has a typical Castilleja corolla with short lower lip. The variation in calyx lobing is very marked. One of these transitional species, C. breviflora Gray, has a rather trisaccate lower lip recalling Orthocarpus, but of the calyx Gray says: “the calyx in flowers of the same spike is sometimes about equally cleft behind and before, and sometimes split in front while the posterior cleft is no deeper than that between the lateral lobes.”—Am. Jour. Sci., ser. 2, 34:338, 1862. Closely allied species such as C. lutea Heller, C. longispica Nels., C. flava Wats., are undoubted Castillejas. The corolla characters and bifid calyx of O. mexicanus Hemsl., make it a Castilleja. Several other Castillejas have been described which are in this group. Among them C. arachnoidea Greenm., has been transferred to O. pilosus var. arachnoideus Jepson. Since all of the above-named species are perennials another bond of relationship is demonstrated between them and Castilleja in which genus the perennial character predominates, whereas in true Orthocarpus the species are all annual.

Orthocarpus beldingi Greene, has been put into a new genus as Clevelandia beldingi Greene. It is generically distinct in having a curved, funnel-formed corolla with lower lobes spreading, not saccate, and in having the stamens included in the tube.

The genus Orthocarpus as here restricted includes annual herbs with calyx tubular-campanulate, 4-cleft, or cleft before and behind and the divisions 2-lobed; corolla tubular, the galea narrow, not greatly (or not at all) exceeding the conspicuous, inflated lower lip.

Review of Literature on Orthocarpus

The genus Orthocarpus was first described by Nuttall, Gen. Am. 2:56, 1818. The name came from two Greek words meaning “straight-fruit” to distinguish this genus from Melampyrum. Nuttall’s type species was luteus which he very carefully described. In 1835 the second contribution to this genus was published by Bentham, Scroph. Ind. 12-13, 1835, in a synopsis in which he described eleven new species and
made one new combination. Among the early contributions of particular value are those of Bentham, Pl. Hartw. 329-330, 1839, Walpers, Repert. 3:392-393, 1845, Bentham in DC. Prod. 10:534-537, 1846, Watson, Bot. King's Exp. 457-459, 1871, Gray, in Bot. Calif. 1:575-580, and 2:475-476, 1876, Gray, Syn. Fl. 2:299-302, 1878; 2:452-453, 1886. Watson's treatment, above mentioned, is the most recent synopsis of the genus although Gray's account in the Synoptical Flora is complete for the known North American species. Some fifty-five species have been described to date by various authors. The sections for Orthocarpus first appeared in Bentham and Hooker, Genera Plantarum 2, pt. 2:974, 1876, and their treatment has been generally followed up to the present time.

PHYLOGENY WITHIN THE GENUS

Within the genus Orthocarpus as above limited I propose to recognize twenty-five species, all annuals, of which one is from the Andes Mountains of South America, the other twenty-four from Western North America.

Three sections have been recognized by Gray, in Bot. Calif. 1:575, 577, 578, 1876, who followed Bentham and Hooker, Gen. Pl. 2. pt. 2:974, 1876, except that he placed the section Oncorhynchus (Lehm.) Benth. & Hook., under a new section Castillejoidea. This treatment has been accepted by subsequent writers. However, I have found that his section Triphysaria contains two clearly marked groups and I would propose a new nomenclature recognizing two subgenera, one containing three sections, as follows:

I. Anthers 2-celled. Subgenus *Euorthocarpus* (Benth. & Hook.) n. comb.
   1. Bracts green throughout; lower lip 3-saccate.
      Section 1. *Cordylanthoides* n. sect.
   2. Bracts colored at tips; lower lip 3-saccate or 3-plicate.
      Section 2. †*Castillejoides* Gray.
   3. Bracts colored at tips; lower lip simply-saccate.
      Section 3. *Monosaccus* n. sect.

II. Anthers 1-celled. Subgenus ‡*Triphysaria* (F. & M.) n. comb.

† Castillejoides Gray, in Bot. Calif. 1:575, 1876.
Figure 1. Phylogenetic Chart of the Species of Orthocarpus
The accompanying phylogenetic chart graphically represents the writer’s conception of the genus. The subgeneric line drawn does not separate two divergent primitive lines of development but rather points out that one group of four species has progressed far beyond its probable ancestral origin. These four species compose the small subgenus, *Triphysaria*, characterized principally by the one-celled anthers, which is a return to the original conception for the genus of that name. In addition, each species within it has developed unique floral characters that should be considered highly specialized. To name a few of these we have the deep sacs of the lower lip and the long filaments of *floribundus*, the unique diminutive corolla of *pusillus*, the narrow sharp galea of *erianthus* and *floribundus*. It is highly probable that these species had their origin from such a species as *campestris* in the section *Cordylanthoides* which is remarkable in having the lower cell of the anther vestigial, indicating a reduction in this organ.

The subgenus *Euorthocarpus* includes all those species bearing two-celled anthers. The sections *Cordylanthoides* and *Castillejoides* compose one large group as opposed to the section *Monosaccus*. The more primitive of these is *Cordylanthoides*, named after the genus *Cordylanthus* which it resembles in having the bracts green throughout. Its five species are closely related and are all yellow-flowered except for one white-flowered variety under *lithospermoides*. The members of the section *Castillejoides* are suggestive of these differing principally in having bracts with colored tips. The six species found here, in addition to the colored spike, have a greater development of the teeth on the lower lip than those of the first section. One of these species, *O. castillejoides*, shows an abundant variety of forms and is apparently in a very active state of evolution. It is closer to the genus *Castilleja* than the other species of *Orthocarpus* and perhaps there is a connection of the two genera through this species. From *castillejoides* the other species of the section have probably been derived. The third section of this subgenus with its ten species differs from the others in having a lower lip of one sac. The name, *Monosaccus*, refers to this characteristic. Another striking difference that is noticeable in all these species except *luteus, tolmiei*
and *purpureo-albus*, is in the bracts which are abruptly different from the leaves in being very broad, often highly colored, and in most cases chartaceous.

**Key to the Species**

A. Anthers 2-celled. .................................. Subgenus Euorthocarpus

B. Corolla more or less 3-saccate; seed coat loose-fitting (tight-fitting in *O. campestris*).

C. Bracts green throughout; corolla deeply 3-saccate; galea equaling or barely exceeding lower lip; teeth inconspicuous. ............ §Cordylanthoides

D. Lower cell of anthers $\frac{1}{4}$ or $\frac{1}{5}$ as long as upper cell; bracts entire. .................. 1. *O. campestris*

DD. Lower cell of anthers not less than half as long as upper cell; bracts cleft into linear or lanceolate lobes.

E. Galea finely pubescent or puberulent, not white-villous.

F. Lower lip of corolla 5-8 mm. wide. . . . . . . 2. *O. lithospermoides*

FF. Lower lip of corolla 4 mm. wide or less.

G. Ventral margins of galea pubescent; sacs of lower lip 3-5 mm. deep; pistil usually equaling galea. .................. 3. *O. lacerus*

GG. Ventral margins of galea glabrous; sacs of lower lip ca. 2 mm. deep; pistil not equaling galea. .................. 4. *O. hispidus*

EE. Galea densely white-villous. ............... 5. *O. lasiorhynchus*

CC. Bracts tipped with purple or yellow; galea exceeding lower lip; teeth erect. ......... §Castillejoides

D. Corolla wider above, lower lip more than 2 mm. deep; spike usually conspicuous, wider than the spread of leaves.

E. Stems pubescent or nearly glabrous; spike showy.

F. Galea nearly straight, pubescent.

G. Leaves oblong, more than 3 mm. wide, entire or with rounded teeth; stems usually ascending; older plants tend to form mats with many long ascending stems. Saline situations. ......... 6. *O. castillejoides*

GG. Leaves lanceolate, less than 3 mm. wide, with lanceolate divisions, attenuate; stems erect. .................. 7. *O. densiflorus*

FF. Galea hooked at tip, densely bearded on back; stems purple. .................. 8. *O. purpurascens*

EE. Stems villous-pubescent above; spike pale. Sierra Nevada foothills. ............... 9. *O. linearilobus*
DD. Corolla linear, lower lip 2 mm. or less deep; teeth % as long as lower lip; spike rather inconspicuous.

E. Corolla whitish; bracts tipped with yellow; spike slender..................10. *O. attenuatus*

EE. Corolla purplish; bracts tipped with purple; spike wider. Andes Mts., S. Am..........11. *O. laciniatus*

BB. Corolla simply saccate or nearly so; seed coat tight-fitting or ridged.....................§Monosaccus

C. Bracts and calyx strongly glandular-pubescent; bracts gradually differing from upper leaves (except in *bracteosus*); style glabrous under the microscope.

D. Corolla yellow.

E. Leaves pubescent; corolla pubescent; galea terminating in a minute hook........12. *O. luteus*

EE. Leaves puberulent; corolla glabrous; galea inflexed, cuculate at tip..............13. *O. tolmiei*

DD. Corolla white or purplish.

E. Bracts linear, middle lobe 1.5-2 mm. wide; leaves dark green. Rocky Mts.........14. *O. purpureo-albus*

EE. Bracts lanceolate, middle lobe 2.5-3 mm. wide; leaves light green. Northwest coast ........................................15. *O. bracteosus*

CC. Bracts and calyx not glandular-pubescent; bracts abruptly differing from upper leaves; style finely pubescent under the microscope (glabrous in *barbatus*).

D. Galea pubescent, even at tip.

E. Lower bracts prominently margined with flattened white hairs; galea distinctly hooked; leaves filiform or filiform-lobed, gray-green .........................16. *O. tenuifolius*

EE. Lower bracts not prominently margined with hairs; galea straight or curved; leaves linear-lanceolate or linear-lanceolate-lobed, deep green (*barbatus* with leaves and bracts as in *tenuifolius*).

F. Galea straight, triangular, tip bearing a bearded tuft of hairs..................17. *O. barbatus*

FF. Galea curved, margins inrolling, tip pubescent.

G. Corolla 20-25 mm. long; galea exceeding lower lip by 3-5 mm....................18. *O. cuspidatus*

GG. Corolla 12-15 mm. long; galea equaling or exceeding lower lip by less than 2.5 mm.................................19. *O. copelandi*

DD. Galea puberulent, glabrate at very tip.
E. Corolla 20-30 mm. long; tip of galea flexed
1 mm., galea surpassing lower lip 2.5-3 mm.

EE. Corolla 10-18 mm. long; tip of galea in-
flexed 0.5 mm., galea surpassing lower lip
c. 1 mm.

20. *O. pachystachyus*

21. *O. imbricatus*

22. *O. erianthus*

23. *O. faucibarbatus*

24. *O. pusillus*

25. *O. floribundus*

### Treatment of Species


Stems simple, few- or many-branched, 1-2.5 dm. high, branches slender, the lower very long; herbage glabrous below; leaves entire, linear-lanceolate, 1.5-4 cm. long; spike wide, compressed, 2-8 (-10) cm. long; bracts same as the leaves, glabrous, ciliate-margined, or puberulent, 1-2.5 cm. long; calyx strongly hirsute, 2-cleft, each division in turn 2-cleft with lanceolate teeth; corolla white or yellow, with occasional purple markings on sides of galea, 15-25 mm. long, lower lip very ample, abruptly widening from the tube, puberulent, ca. 5 mm. long, 3.5 mm. deep, teeth white, oblong, erect, 1.5-2 mm. long, lower lip villous within at base of teeth; galea straight, narrow, subulate, puberulent, surpassing lower lip 1 mm., 5-6 mm. long; anthers 2-celled, upper cell 4 or 5 times the length of lower one, glabrous, filaments glabrous,
free ca. 4 mm.; pistil equaling or slightly exceeding galea, glabrous, stigma globose or somewhat two-lobed; capsule ovate, brown, shiny, 5-7 mm. long; seeds many, irregular, narrow, 0.75 mm. long, coat thin, close-fitting.

Distribution: valleys at middle altitudes, sometimes standing in water in marshy places; occasional from Lake County, Oregon, to Sacramento Valley, California; probably introduced into Santa Clara County. Type locality: Sacramento Valley. OREGON: Riley, Harney County, Cooper in 1914 (WS); Button Springs, Lake County, Leiberg 791 (G, WS, UC); Swan Lake, Klamath County, Applegate 390 (Applegate Herbarium). CALIFORNIA: Modoc County, Baker in 1893 (G, UC); Upper Sacramento, Hartweg 1902 (probably type collection, G), Stillman (G); Goose Valley, Shasta County, Eastwood 962 (G, CA); Pratts-ville, Jones in 1897, (type collection for O. columbinus, Po, CA), Coombes in 1906 (G, CA); North Sacramento, Rame-ley 11240 (UC); Butte County (?), Summers in 1886 (UC); Frenchman's Dam, Santa Clara County, Stinchfield 482 (St).

This well defined species seems to be a connecting link between the subgenus Euorthocarpus and the subgenus Tri-physaria as regards the anther character which distinguishes these groups. In this species the lower cell of the anther is very small, often apparently infertile, which seems to point out that the one-celled anther group arose from the two-celled through the loss of the lower cell. Orthocarpus columbinus Jones, is genuine campestris.


Stems stout, erect, simple or few-branched above, 1.5-5 (-7) dm. high; herbaceous parts pilose-pubescent; leaves 2-8 cm. long, entire below, lanceolate or 3-5-7 parted above into linear divisions; spike heavy, condensed; bracts same as upper leaves, 10-25 mm. long, 5-10 parted with divergent, attenuate lobes, 5-8 mm. wide at base, about equaling tube of corolla; calyx 8-14 mm. long, cleft half way with 4 subequal attenuate lobes, strongly hirsute; corolla clear yellow or white turning pinkish with age, usually 2 (or 1) purple spots at base of lower lip, 15-25 mm. long, pubescent or puberulous, tube extending be-
yond calyx, lower lip widely expanding from throat, each sac globose or conical, 4-6 mm. deep, 4-6 mm. long, inner margin floccose, teeth oblong, 2-3 mm. long; galea straight, subulate, exceeding lower lip 0.5-3 mm.; stamens enclosed in galea, filaments glabrous or more rarely pubescent, anthers pubescent, 1.5-2 mm. long; pistil included in galea, glabrous, often flattened toward the small somewhat 2-lobed stigma; capsule ovate, brown, 5-6 mm. long; seeds many, in thin loose-fitting reticulate coats.

A. Corolla clear yellow. Coastal Valleys and foothills from Santa Clara County, California, to southern Oregon ................................................................. 2a. var. typicus

AA. Corolla white turning pinkish with age. Valleys, Napa County, Lake County, to Butte County, California ................................................................. 2b. var. bicolor

2a. Orthocarpus lithospermoïdes var. typicus, nom. nov.


Distribution: coastal valleys and foothills from southern Oregon to Santa Clara County, California. Type locality: California, probably near San Francisco. OREGON: Glendale, Howell 1247 (in part, WS), in 1887 (UC), Jones in 1902 (Po); Grant’s Pass, Howell 239 (G). CALIFORNIA: Douglas (probably type collection, G); Carlotta, Humboldt County, Haaver in 1915 (CA); Dyerville, Jones in 1924 (Po); Laytonville, Jones in 1924 (Po); Ukiah, Jones in 1924 (Po); Lakeport, Munz 9877 (Po); Napa, Heller 5602 (G, St); Fairfield, Heller & Brown 5370 (RM, St, Po, G); Fairfax Meadows, Marin County, Eastwood in 1907 (G, CA); N.E. of Mt. Diablo, Brewer 1132 (G); Crystal Springs, Abrams 2440 (Po, RM, St, G); Stanford University, Baker 662 (Po, WS, G, CA, UC); Saratoga, Pendleton 704 (Po); Santa Cruz, Jones in 1881 (Po); Gilroy, Ferris in 1922 (St).

This plant might be confused with the large form of O. lacerus found in Butte County, but the ranges of the two species do not approach each other. The material of variety
typicus shows little variation throughout the range. However, this plant apparently hybridizes readily and material of this kind is not uncommon in herbaria. Experimental work is necessary here to determine the possibilities of hybridization with other species but it apparently crosses with O. densiflorus var. typicus as found at Stanford University, Baker 663 (Po, G); Clear Lake, Abrams 2419 (St); Potter Valley, Mendocino County, Purpus in 1889 (UC); Tiburon, Marin County, Brandegee in 1909 (in part, UC). Also it apparently hybridizes with O. castillejoides var. typicus as, near Napa, Heller 5601 (G, St); Napa Valley, Greene 1961 (G) approaches the hybrid. Another plant from Napa County, Sonne in 1888 (in part, UC), I judge is a cross with O. purpureascens var. typicus. Plants from the Rogue River watershed, Oregon, have been found which approach O. hispidus, Glendale, Howell 1247 (in part, WS), Henderson 1408 (G); Cow Creek Mountains, Cusick 4854 (WS).


Distribution: valleys from southern Siskiyou County, through Butte County, to Lake and Napa Counties, California. Type locality: Clear Creek, Butte County. "California", Fremont 437, 479 (G), Hartweg (G); Hilt, Siskiyou County, Smith in 1915 (CA); Goose Valley, Shasta County, Eastwood 962 (in part, CA); Clear Creek, Butte County, Heller & Brown 5519 (type collection, Po, St, RM, G), Heller in 1914 (St); 5 mi. N. W. of Hamilton, Glenn County, Heller 11346 (G, CA, St, UC); Leesville, Heller 13116 (G, CA, St); Indian Valley, N. Lake County, Jepson 9001 (type of O. rubicundulus, Jepson Herbarium); Hough's Springs, Lake County, Heller 12380 (G, St, CA); Knoxville Ridge, Jepson 9042 (Po, UC); Knoxville, Baker 2965 (Po, RM, G, CA, UC); Calistoga, Eastwood in 1900 (RM); near Petrified Forest, Eastwood 4589 (CA).

This plant was first described by Bentham, Pl. Hartw., 329, 1839, from a specimen collected in the Sacramento Valley. He
called it a form of *O. lithospermoides*. In the Sacramento Valley the plants are exceedingly robust and the flowers are usually larger than in var. *typicus*. It was this material that Heller named *O. bicolor*. In Lake and Napa counties this variety is smaller flowered and the spikes are narrower. However all gradations are found in the herbaria so I can not agree with Jepson that this is a distinct species, *O. rubicundulus*.


Stems rather weak, erect, simple or with ascending branches, 1-3 dm. high, purplish, hirsute-pubescent; leaves linear, 1-5 cm. long, entire or pinnately parted into 3-7 linear divisions, pubescent with occasional glands; spike wider and less compact than in *O. hispidus*, 2-15 cm. long, upper flowers divergent and extending beyond tip of spike; bracts 10-20 mm. long, palmately 3-5-7 cleft into subequal linear lobes; calyx cleft almost halfway with 4 subequal, widely lanceolate lobes, 7-10 mm. long on the flower, as much as 12 mm. long on the fruit, half as long as corolla, bracts and calyx pilose, scarcely glandular; corolla deep yellow, usually with two purple dots at base of lower lip, soft-pubescent, 10-18 mm. long, tube twice as long as lower lip and gradually expanding into it; lower lip inflated, 4-5 mm. long, ca. 4 mm. deep, teeth narrowly oblong, 1 mm. long; galea subulate, acute, 4-6 mm. long, 3-4 mm. wide, pubescent without and within including inner margins, straight; stamens glabrous, anthers 1.5 mm. long, filaments free 4 mm.; pistil glabrous, longer than in *O. hispidus*, ca. equaling tip of galea; capsule oblong or elliptical, light brown, 5-7 mm. long; seeds many, in a loose-fitting reticulate coat.

Distribution: common on the western slope of the Sierra Nevada Mountains from 3000-7000 feet elevation, southern Oregon to Fresno County, California. *Type locality*: Sacramento Valley. OREGON: Keno, Klamath River, Applegate 391 (G). CALIFORNIA: Hartweg 1901 (probably type collection, G); Yreka, Butler 1407 (Po, RM, UC, St), Greene
828 (G); Mt. Eddy, Heller 13260 (G, CA, St); Goose Valley, Shasta County, Eastwood 752 (G, CA); Pitt River, Smith 307 (G, CA), 220 (CA); Redding, Heller 7909 (G, UC, St); South Yollo Bolley, Jepson 1897 (UC); Red Clover Valley, Plumas County, Heller & Kennedy 8752 (G, UC, St); Prattville, Heller & Kennedy 8797 (G, St), Coombes in 1902 (G, UC); Berry Canyon near Clear Creek, Heller & Brown 5459 (type collection for O. brownii, Po, RM, St, G); Chico, Bidwell in 1878 (G); Nevada City, Eastwood 587 (G, CA); Emigrant Gap, Jones in 1882 (Po); Auburn, Ames in 1886 (G); Cisco, Heller 13295 (G, St), Bolander & Kellogg (G); Gregory, Jones 243 (G); Yosemite, Hall & Babcock 3324 (Po, RM, UC, St); North Fork of Kings River, Hall & Chandler 149a (UC).

The three species lacerus, hispidus and lithospermoides are closely related. Orthocarpus lacerus is very similar in appearance to O. lithospermoides in its larger forms but it is more often confused with O. hispidus in the smaller forms. Plants of lacerus when grown in a dry or barren situation will produce flowers that would be small for hispidus. Intermediates between the latter two species occur where their distributions overlap. The collection from Soda Springs, Nevada County, Jones 2599 (Po), is one of these. Since the size of the corolla varies in the field the most reliable character to distinguish this species from hispidus is the pubescence found within the galea near the margins.


Stems slender, erect, simple or with few erect branches, hirsute-pubescent, 1-4 dm. high; leaves 1-4 cm. long, pubescent, lower linear, entire, upper lanceolate, 3-5 cleft; spike slender, compact, 3-15 (-20) cm. long, herbage of inflores-
cence hirsute to pilose and sometimes slightly glandular, corollas usually not extending above tip of spike; bracts 10-25 mm. long, ovate, 3-7 cleft into attenuate lobes; calyx 8-10 mm. long, cleft half way before and behind, each lobe cleft into two attenuate teeth; corolla white or yellow, 12-20 mm. long, pubescent, exceeding bract, (upper flowers exserted from spike) lower lip small, 3-4 mm. long, ca. 2 mm. deep, teeth oblong, small; galea straight or curved, narrow, 4-5 mm. long, 2-3 mm. wide at base, lanceolate, margins on ventral side glabrous, exceeding lower lip 1-2 mm.; stamens enclosed in galea, anthers pubescent, 1-1.5 mm. long, filaments naked, free 3-4 mm.; pistil included in galea, extending as far as lower lip, glabrous; capsule oblong, brown, 5-8 mm. long; seeds numerous, small, brown, in a loose reticulate coat.

Distribution: common in valleys to 6000 feet, northern Idaho to northwestern Nevada; Alaska to southern Oregon; eastern California south to Lake Tahoe; very rare in southern California. Type locality: banks of the Columbia. IDAHO: Camas Prairie, Blaine County, Macbride & Payson 2911, 3833 (G, RM, CA, UC, Po, St); House Creek, Owyhee County, Nelson & Macbride 1770 (RM, G); Big Willow, Macbride 121 (G, RM, WS). NEVADA: Humboldt Reserve, Elko County, Kennedy 4249 (G); Carson City, Anderson in 1865 (G); Washoe Lake, Jones in 1897 (Po, RM); King's Canyon, Baker 1138 (Po, RM, CA, UC, G). ALASKA: Skagway, Eastwood 752a (G, CA). VANCOUVER ISLAND, B. C.: Victoria, Macoun 722 (G). WASHINGTON: Wenatchie region, Brandegee 1023 (G); Sprague, Sandberg & Leiberg 153 (G, WS, UC); Spokane, Piper in 1896 (G, WS); Falcon Valley, Suksdorf 2779 (type collection for O. rarior, WS, G, UC, St); Silver Lake, Henderson 2265 (WS). OREGON: Portland, Sheldon S10829 (Po, G, WS, St); Big Meadows, Des Chutes River, Leiberg 507 (G, UC, Po); Klamath Lake, Peck 9498 (G). CALIFORNIA: Yreka, Greene 852 (G); Quartz Valley, Butler 1461 (Po, St, UC); Goose Valley, Eastwood 957 (G, CA); Lassen's Peak, Jones in 1897 (Po); Brush Creek, Butte County, Conger in 1907 (UC); Chico, Heller 11509 (G, UC, CA, St); Donner Lake, Heller 6907 (type collection for O. tenuis, G, UC, RM, St, Po); Greene Valley, San Bernardino
County, Shaw & Illingsworth 65 (St); Palomar Mt., Parish 447I (G, UC, St), 4475 (type for O. falcatus, CA).

This species varies in flower color from white to a deep yellow. In general white seems to be the early season flower color while yellow is the late season shade. Plants that are grazed or otherwise injured in the spring are retarded so that they may produce yellow flowers a month or two after the uninjured plants of the field have produced white blooms. A top injury is often responsible for branching which occasionally occurs in this species. The material for O. hispidus var. tenuis Macb. & Pays., was of this nature. O. rarior Suksdorf, and O. tenuis Heller, are genuine hispidus. The Parish collection from Palomar Mt., southern California, which was described as O. falcatus Eastwood, shows only the minor variations one would expect in plants 500 miles out of their range. The falcate galea can be duplicated in the plants of the Tahoe region and elsewhere.


Stems erect, simple or branching from near the base, slender, 1-3 (-4) dm. high, hirsute, often purplish; leaves 1-3 cm. long; entire or seldom with 2 or 4 lateral lobes, linear or linear-lanceolate, pubescent, loose spike 2-15 cm. long; bracts 6-12 mm. long; 3-5 parted with linear divisions, soft-hirsute, uppermost tipped with lemon-yellow and almost bearded, calyx 6-12 mm. long; equaling bract, more hispid, cleft into two lobes each with two attenuate teeth, corolla yellow, 12-22 mm. long, twice as long as calyx and bract, tube slender, glabrate or pilose-pubescent, abruptly expanding into lower lip which is glabrous or glabrulate, inflated, 4-5 mm. deep, 6-7 mm. long, teeth bearded, 2 mm. long, erect but not exceeding the protruding lower lip; galea straight, narrow, bearded, exceeding lower lip 2 mm.; capsule 6-9 mm. long, elliptical, light brown; seeds many, in loose-fitting alveolar coats.

Distribution: montane, 4000-6500 feet; southern California from the eastern half of the San Bernardino Mountains to the
Cuyamaca Mountains, San Diego County; southwestern Arizona. *Type locality:* Mohave River, north slope of the San Bernardino Mountains. Southern California, Parry & Lemmon 318 (G); Mohave River, Palmer 313 (type, G); Little Bear Valley, San Bernardino Mountains, Parish 482 (G, UC), 10950 (UC, St); Fish Camp, San Bernardino Mountains, Johnston 2916 (Po, RM); Green Valley, San Bernardino Mountains, Chandler in 1897 (UC); Big Bear Valley, San Bernardino Mountains, Parish 482 (G), 10931, 3766 (G, UC, St), 3048 (UC), Wilder 760 (Po), Abrams 2107 (Po, St), Harwood 4376 (Po, RM), Edwards in 1916 (Po), Pierce in 1922 (Po); San Bernardino Mountains, Hall 1001 (RM), 1302 (UC), Wright 246 (G); San Jacinto Mountains, Hall 649 (UC, St), Parish 482 (St); Cuyamaca Valley, Greene 408 (G). Arizona: Valley of the Hassayampa, Palmer 313 (UC).

The center of distribution is in the eastern half of the San Bernardino Mountains. It has rarely been collected at other stations. The species is distinct from the others of its section and is a constant one in the field.


Annual or occasionally biennial herbs with simple erect stems or corymbosely branched with many ascending or decumbent branches often 0.5-1 m. long, plant usually 1-3.5 dm. high, stems puberulent to hirsute; leaves lanceolate to oblong (or ovate), acute or obtuse, 1-5 cm. long, pinnately toothed with 1 or 2 pairs of rather short lanceolate lobes above, entire below, scabridus-puberulent; spike often subcapitate, terete, or extended becoming more lax below, 3-8 (-12) cm. long; bracts green or upper ones tipped with yellow or purple, oblong to ovate in outline, 14-22 mm. long, palmately cleft into 2-8 lateral lobes usually obtuse or truncate; calyx 12-20 mm. long, deeply parted in back, cleft in front, each lobe bearing a pair of linear attenuate or rounded teeth, villous, tipped with color as the bracts; corolla yellow with purple markings, 14-25 mm. long, exceeding bract and calyx, tube sparingly hirsute, gradually expanding into lower lip; lower lip shallowly, or rather deeply, 3-saccate, 4-6 mm. long.

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not including erect obtuse purple (sometimes yellow) teeth, 1-3 mm. long; galea straight or slightly curved, exceeding lower lip 2-4 mm., margins membranous, tip obtuse; stamens inserted in the galea, filaments glabrous, anther-cells sparsely ciliate; pistil glabrous, stigma exserted from tip of galea, capitate or slightly 2-lobed; capsule brown, elliptical, 8-12 mm. long; seeds many, large, yellowish, enclosed in loose reticulate coats.

A. Bracts tipped with white or yellow or pinkish; lower lip of corolla yellow with purple dots.

B. Leaves usually widely lanceolate; spike terete

BB. Leaves oval or elliptical, broader and shorter than var. typicus; spike compressed to a wide subcapitate inflorescence

AA. Bracts tipped with purple; lower lip of corolla purple with outer third yellowish. Humboldt County

6a. Orthocarpus castillejoides var. typicus, nom. nov.


Distribution: saline soils along the coast from Vancouver Island, B. C., to Monterey County, California. Type locality: California, probably San Francisco or Monterey. VANCOUVER ISLAND: Alberni, Henry in 1916 (CA). WASHINGTON: Everett, Piper 4987 (WS, G); Copalis, Conard 385 (WS, G). OREGON: Astoria, Cooper (G); Yaquina Bay, Lawrence 1822 (St); Bandon, Peck 9001 (G). CALIFORNIA: Douglas (probably type collection, G); Pebble Beach, Del Norte County, Parks 8261 (UC); Humboldt County, Holman in 1925 (UC); Fort Bragg, Eastwood in 1902 (type for O. maculatus, CA); Duncan’s Mills, Jones in 1882 (Po); Point Reyes P. O., Elmer 4938 (type collection for O. longispicatus, Po, CA, St); Vallejo, Greene 165 (G); San Francisco, Kellogg in 1866 (G, UC); Moss Beach, Brandegee in 1905 (G, RM, UC); Monterey, Hall 10068 (G, UC).
This species more closely resembles the genus Castilleja than any other Orthocarpus here treated. It includes the rankest growing representatives of the genus and among the marsh plants especially, many times it has been mistaken for a Castilleja on account of the spreading habit, truncate bracts and inconspicuous flowers. Also the plants actually growing in water occasionally produce a biennial root which confuses these with members of the genus Castilleja. This species is the most difficult within the genus for the taxonomist to handle for it is extremely variable. Each colony seems to produce a unique form of its own. Many of these are certainly ecological for the species grows in various saline soils along the coast and some of the plants actually grow in the salt water. In herbaria the most common form is the plant with decumbent branches and with a conspicuous lower lip on the flowers. In this treatment I recognize two varieties in addition to typicus because of their geographic isolation and the constancy and the importance of their characters. A large number of minor variations exist in the species. Orthocarpus maculatus Eastwood, is a synonym, the type being one of the commoner forms of this variety. Orthocarpus longispicatus Elmer, seems to me to be an ecological form and since Elmer's one collection is all I have seen of this I do not give it a higher rank though it looks quite different from the rest. Specimens from Noyo, Mendocino County, Bolander 6538 (UC), and the salt marshes, San Francisco, Kellogg & Harford 705 (G), are undoubtedly hybrids between var. typicus and O. purpurascens var. latifolius. A cross between this variety and O. purpurascens var. typicus was found at Carmel Bay, Elmer 5084 (St). (See discussion under O. lithospermoïdes var. typicus.) Some of the variations make this plant easily confused with O. densiflorus. It has been introduced into New Mexico, Santa Fe, Dudley in 1908 (St).


Leaves oval or elliptical, broader and shorter than var. typicus, 10-25 mm. long, 5-12 mm. wide; spike compressed to a wide subcapitate inflorescence. Otherwise as var. typicus.
Distribution: Monterey County. **Type locality:** Pacific Grove. **CALIFORNIA:** Andrews (G), Monterey, Parry in 1883 (G), Brewer 663 (G), Patterson & Wilts in 1907 (St); between Point Pinos and Pacific Grove, Heller 6745 (Po, RM, G, UC, St).

6c. *Orthocarpus castillejoides* var. **humboldtiensis**, var. nov.

Bracts and calyx purple-tipped, each lobe of bract truncate; corolla purplish, throat purple, lower lip with outer third yellowish, teeth very large, 3 mm. long, purple. Otherwise as var. *typicus*.

**Type:** from saline flats, Eureka, Humboldt County, California, June 20, 1925, *P. A. Munz* 9890 (Pomona College Herbarium No. 71753).

Distribution: salt marshes of Humboldt Bay. Humboldt Bay, Abrams 8249 (RM, Po, St), 7087 (St), Kellogg & Harford 701 (G, CA), Rattan (St, G), Dudley in 1899 (St); Samoa, Tracy 867 (UC), Dudley in 1899 (St).


Stems erect, branching, 1.5-3.5 dm. high, puberulent, yellowish, slender; leaves sessile, linear or linear-lanceolate, attenuate, usually entire below, above with two linear lobes, puberulent or finely pubescent, 2-8 cm. long; spike dense, 2-10 cm. long, average 4 cm. long, purplish; bracts 8-20 mm. long, usually 3-lobed, occasionally 4- or 5-lobed, upper bracts purplish-tipped (white-tipped in var. *obispoensis*), pubescent; calyx 10-25 mm. long, pubescent as bracts, cleft a third to half way with 4 subregular linear lobes, tips expanded and pink (creamy-white in var. *obispoensis*), ca. equaling throat of corolla; corolla 10-25 mm. long, yellow or purplish, usually with 3 prominent purple spots on the anterior part of the lower lip, pubescent, lower lip 2-4 mm. long, teeth 1.5-2.5 mm. long, ca. equaling galea, purple (white in var. *obispoensis*); galea 6-7 mm. long, subulate, puberulent without; stamens glabrous, anthers 2 mm. long, filaments free 5-8 mm.; pistil glabrous, stigma exserted from tip of galea, globose or 2-
lobed; capsule ovate, 7-10 mm. long; seeds black, ca. 0.5 mm. long, in a loose-fitting cone-shaped reticulate coat.

A. Spike purplish, galea purple.
   B. Bracts equaling corolla; corollas not exserted in the spike, lower lip not as deep as long, teeth 1-2.5 mm. long..................7a. var. typicus
   BB. Bracts equaling throat of corolla; corollas exserted from the spike, lower lip as deep as or deeper than long, teeth minute...............7b. var. gracilis

AA. Spike whitish, galea white...............7c. var. obispoensis

7a. Orthocarpus densiflorus var. typicus, nom. nov.


Spike dense, purplish; bracts equaling corollas; corollas not exserted from spike, lower lip longer than deep.

Distribution: a common species extending along the California coast from Mendocino County to Los Angeles County. Rare in the Sierra Nevada foothills. Type locality: probably San Francisco or Monterey, possibly Santa Barbara. CALIFORNIA: Douglas (probably type collection, G); Willets, Jones in 1924 (Po); Healdsburg, Heller & Brown 5236 (Po, G, RM, St); Santa Rosa, Heller & Brown 5307 (Po, G, RM, St); Lagunitas, Eastwood 43 (G, CA); Berkeley, Walker 175 (Po, UC); Livermore, Bioletti in 1892 (RM); Stoney Creek, Amador County, Hansen 1675 (St); French Flat, Tuolumne County, Ferris 1507 (St, CA); San Francisco, Heller 6596 (Po, G, RM, UC, St); Stanford University, Baker 621 (G, Po, UC), Abrams 2348 (RM, Po, G, St), 1551 (Po, St); Del Monte, Heller in 1903 (G); 15 mi. N. E. of Morro, Munz & Keck 10198 (Po); Morro Creek, Munz 9202 (Po); Bear Creek, Tulare County, Purpus 1719 (UC); Santa Monica, Crawford & Hiatt in 1916 (Po); Los Angeles, Greata in 1899 (St).

This species is closely related to every other in the section with the possible exception of O. laciniatus. Occasional plants approach attenuatus and castillejooides and are confusing inter-
mediates. A distinct form from Inverness, Marin County, *Eastwood in 1901* (type for *O. noctunus*, CA), seems to me to have *lithospermoïdes* qualities which suggest hybrid origin. Hybrids undoubtedly do occur between these two species (see discussion under *O. lithospermoïdes* var. *typicus*). Gray, in Bot. Calif. 1:576, 1876, says, "... the var. *latifolius*, Benth., with few or no lobes to the cauline leaves, is the commoner form." I have not found Bentham's original reference.

7b. *Orthocarpus densiflorus* var. *gracilis* (Benth.), comb. nov.


Bracts equaling throat; corollas exserted from spike, lower lip conical or rounded, as deep as or deeper than long.

Distribution: Monterey and Santa Barbara counties, near the coast, appearing again in lower Orange County and San Diego County where it is plentiful at moderate altitudes as well as along the coast; it extends south into Lower California. *Type locality*: probably Monterey. CALIFORNIA: Douglas (probably type collection, G); Santa Lucia Mountains, Monterey County, *Eastwood in 1897* (UC, G), in *1898* (G), *Brandegee in 1909* (UC), Ferris 1803, 1852, 3665 (St); Jolon, *Eastwood 4086* (G); Paso Robles, Barber in *1899* (UC); 10 mi. E. of Lompoc, *Munz & Keck 10309* (Po); Claremont, *Shaw 454* (St); Capistrano, *Abrams 3266* (G, Po, UC, St); Henshaw Dam, San Diego County, *Munz 10341* (Po), *Jaeger in 1926* (Po); Cuyamaca Mountains, *Parish 482* (G); Cuyamaca Lake, *Munz 9781* (Po); Julian, *Keck, Hill, McCully 128* (Po); Otab Creek, *Peirson 3372* (Po); LaJolla, *Clements 127* (G, UC); San Diego, *Brandegee 821* (WS, Po, G, CA, UC); Ensenada, Lower California, *Jones 3722a* (Po, G, RM).

The material from the Santa Lucia Mountains, Monterey County, with the white deeply saccate lower lip on the small corollas, quite divergent from the spike and borne on slender multi-branched plants, looks distinct from var. *typicus*. It was
this material that Bentham named *O. gracilis*. However the material a little further south more and more resembles var. *typicus*. The most persistent character for *gracilis* is the white deeply saccate lower lip but in San Luis Obispo and Santa Barbara counties fields are found containing plants with all gradations in the size of the lower lip and the color varies from white to pink regardless of this character. The plants of this large area do not suggest hybrids. Rather they seem to indicate the point of origin for the more distinct *gracilis* of Monterey County. The same situation occurs in southern California. The material from the Cuyamaca Mountains, which Gray named *O. parishii*, has been found, both by field and herbarium study, to be identical with that from the Santa Lucia Mountains. Part of the southern material develops larger corollas but no specific or varietal differences have been found and none were pointed out by Gray. Near the coast of San Diego County the plants approach var. *typicus* until they are indistinguishable from it. Because of this evident origin and the blending of the groups at two different points of their range I reduce *gracilis* to varietal rank under *densiflorus*. This plant unquestionably hybridizes with the varieties of *O. purpurascens* as at San Diego, Brandegee in 1906 (UC).

7c. *Orthocarpus densiflorus* var. *obispoensis*, var. nov.

Spike white, corollas somewhat exserted from spike; corollas creamy-white with few purple dots, lower lip deeply saccate. Otherwise as var. *typicus*.

*Type:* from grassy slope, 1 mile north of Morro, San Luis Obispo County, California, April 8, 1926, P. A. Munz and D. D. Keck 10242 (Pomona College Herbarium No. 89481).

*Distribution:* coastal San Luis Obispo County. Pismo Beach, Munz & Keck 10244 (Po); San Luis Obispo, Jones 3243 (Po, CA, RM), Brewer 476 (G, UC), Brandegee (UC).

In the field the creamy-white spikes recall *O. attenuatus* but they are much too wide and the deeply saccate lower lip is like that in var. *gracilis* which variety this plant closely resembles. Variety *obispoensis* is well isolated both as to characters and distribution. I have seen no intermediates although they are likely to occur.

Stems simple to diffusely branched from near the base, 1-4 dm. high; herbage villous-pubescent; leaves sessile, 10-50 mm. long, few- to many-parted into filiform or linear divisions; spike dense, 2-20 cm. long; bracts 10-20 mm. long, dilated at base, 10-15 mm. across the top, 5 or 7 linear divisions, the middle one usually 3-lobed, ca. equaling the corolla, green at base with a pubescence of long jointed hairs, pale pink to purple above, tips of lobes often swollen and covered with a short pubescence; calyx equaling the bract, the four linear lobes equal, pubescence and markings like the bracts; corolla crimson or purplish, 12-30 mm. long; lower lip purple, crimson, pink, yellow or white, most commonly purple tipped with yellow, 3-7 mm. long, 3-5 mm. across, shallow or rather deeply saccate, teeth minute, ca. 1 mm. long, oval; galea crimson or purple, exceeding lower lip by 2-3 mm., ending in an abrupt hook, densely pubescent on the ridge, ending in a tuft of soft cellular hairs; stamens enclosed in galea, anther-cells sparingly puberulent, 1.5-2 mm. long, filaments densely pubescent to glabrous, 5-10 mm. long; pistil equaling corolla, stigma globose, 1 mm. wide, held in the curved tip of the galea, style glabrous; capsule ovate, 10-15 mm. long; seeds ovate to elliptical, less than 1 mm. long, smooth, in a loose-fitting alveolar coat.

A. Lower lip of corolla purple, sometimes tipped with yellow.

B. Floral bracts green below becoming deep crimson above with the tips of the lobes pinkish. Restricted to the coast regions from Monterey County to Lower California.

C. Floral bracts palmately cleft into filiform or linear lobes 1 mm. or less wide.............8a. var. **typicus**

CC. Floral bracts palmately cleft into linear-spatulate lobes 1-2 mm. wide, tipped with pale lavender and giving the appearance of alternating light and dark bands along the spike; stems many, ascending from the base........8b. var. **latifolius**

BB. Floral bracts green below becoming pale or deep purple above with the tips of the lobes purplish pink.
C. Lower lip deep purple with outer third a bright orange-yellow; whole inflorescence conspicuously red-purple. Western Mohave Desert. 8c. var. venustus

CC. Lower lip purple with outer fifth a dull white. Dry interior valleys, Sacramento Valley south to the Tehachapi Mountains; Riverside County to northern Lower California, east to Arizona. 8d. var. palmeri

AA. Lower lip of corolla yellow or white, never purple. Santa Barbara south to Orange and San Bernardino counties. 8e. var. pallidus

8a. *Orthocarpus purpurascens* var. typicus, nom. nov.


Bracts green, tipped with pink to crimson; lower lip of corolla purple, tipped (sometimes indistinctly) with a dull yellow or white.

Distribution: coastal valleys and foothills from Mendocino County to Lower California. *Type locality*: probably San Francisco or Monterey. CALIFORNIA: Douglas (probably type collection, G); Sulphur Banks, Lake County, *Bowman in 1901* (G), 266 (St); Santa Rosa, *Heller & Brown 5318* (Po, St, RM, G); Bodega Point, *Eastwood 4859*, in 1900, in 1901 (G); Benecia, *Jones 242a* (G), *Greene 114* (G); Bethany, *Baker 2784* (Po, G, CA, UC); San Francisco, *Thurber 474* (G); Stanford University, *Abrams 2382* (RM, St, G, Po), *Baker 620* (G, Po, UC); Seaside, *Heller 6565* (Po, UC, CA, St, RM, G); Del Monte, *Elmer 3572* (G, UC, St); King City, *Eastwood 4065* (G, CA); Morro, *Munz & Keck 10241* (Po); 30 mi. W. of Wasco, *Munz & Keck 10108* (Po); Lompoc, *Munz & Keck 10276* (Po); Santa Barbara, *Cooper in 1879* (G); Santa Cruz Island, *Miller in 1918*, *Swain in 1919* (CA); Saugus, *Munz & Keck 10006* (Po); Santa Monica Mountains, *Munz & Harwood 3943* (Po); Ballona Harbor, *Abrams 1181* (Po, St); Canada Salada, Orange County, *Peirson in 1923* (RM, St); Riverside, *Hall 2930* (Po, RM); San Diego, *Brandegee in 1903*, in 1906 (Po, UC). LOWER CALIFORNIA: *La Grulla, Orcutt in 1886* (UC); Guadalupe Island, *Brandegee in 1897* (UC).
This variety has been introduced into Washington: Seattle, *Piper in 1891* (WS). Albino forms occur as in San Luis Obispo County, near Templeton, *Barber A28* (UC). (For hybridization see discussion under *O. castillejoides*, *O. lithospermoides* and *O. densiflorus*.)


Floral bracts divided into wide and showy lobes which are paler than the corolla, arranged in rows so that the spike appears banded; stems with many branches from the base.

Distribution: occurs along the coast from Humboldt County to Monterey. *Type locality:* Noyo, Mendocino County. Noyo, Mendocino County, *Bolander 6538* (one of type collections, G); Ft. Bragg, *Matthes in 1914* (type of var. *multicaulis*, UC); Sonoma Valley, *Torrey 362* (G); Pt. Reyes, *Davy 6822* (UC); Oakland, *Torrey 365* (G); Alameda, *Kellogg & Harford 704* (G); Lake Merced, *Michener & Bioletti in 1892* (Po), *Heller in 1902* (G, St), *Brandegee in 1907* (UC); near Ocean View, San Francisco, *Heller 8381* (G, CA, UC, St); Montara Point, *Copeland 3298* (Po); Half Moon Bay, *Brandegee in 1905* (UC); Black Mountain, *Elmer 4845* (Po, CA); Santa Cruz, *Gray in 1872* (G), *Jones in 1881* (Po); Monterey, *Brewer 669* (G).

This apparently hybridizes with *O. castillejoides* var. *typicus*, salt marshes, San Francisco, *Kellogg & Harford 705* (G).

8c. *Orthocarpus purpurascens* var. *venustus* (Heller), comb. nov.


A distinct variety in the field with its pronouncedly bright colors; corolla a deep velvet-red except for outer third of lower lip a deep orange-yellow, teeth yellow.
Distribution: this striking variety occurs on the western end of the Mohave Desert, California, growing in the open sandy stretches. It is rather uncommon. Type locality: Kramer, San Bernardino County. Inyokern, Bailey in 1922 (Po); Mohave, Eastwood in 1913 (CA); 10 mi. S. of Mohave, Munz & Keck 10057 (Po); 5 mi. S. of Willow Springs, Munz & Keck 10036 (Po); Kramer, Heller 7677 (type collection, G, St, CA, UC), Brandegee in 1913 (Po, RM, G, UC), in 1905 (UC); 10 mi. N. of Barstow, Johnston 6502 (Po), Shreve in 1915 (UC); Barstow, Parish 9791 (UC, St), 9221 (St), Jepson 5819 (UC); Daggett, Hall 6153 (UC); Calico Mountains, Jepson 5405 (UC); Rabbit Springs, Parish 9755 (St); 15 mi. N. of Victorville, Johnston 6504 (Po); Victorville, Edwards in 1917 (Po); Deadman's Point, Poe & Robinson in 1922 (Po), Parish 10783 (UC); between Manzana and Gorman's, Antelope Valley, Davy 2653 (UC).

8d. Orthocarpus purpurascens var. palmeri Gray, Syn. Fl. 2:300, 1878.

Gray, Syn. Fl. 2:300, 1886.

Upper portion of floral bracts purple making a showy spike; lower lip of corolla purple, the yellow or white tip bearing one or three purple spots.

Distribution: dry interior valleys from Sacramento Valley south, reaching the coast in Orange and San Diego counties and extending from northern Lower California, east into Arizona. Type locality: Wickenburg, Arizona. Anderson, Shasta County, Smith 145 (CA); Red Bluff, Cameron in 1896 (UC); 5 mi. N. W. of Hamilton, Heller 11352 (G, CA, St); Chico, Copeland 3035 (Po, UC, G); Clear Creek, Brown 174 (RM, St); 6 mi. N. of Orville, Heller 10729 (G, UC, St); Auburn, Ames in 1878, in 1891 (G); Ukiah, Setchell in 1901 (UC); near Williams, Colusa County, Ferris 520 (St); Nashville, El Dorado County, Rixford in 1900 (RM); Peoria Pass, Tuolumne County, Ferris 1598 (St); Pine Ridge, Fresno County, (5100 ft. elev.) Hall & Chandler 296 (UC); Goshen, Tulare County, Eastwood 3914 (G, CA); Springville, Purpus 5066 (G); Corcoran, Eastwood 3858 (G, CA); Sunset, Heller 7735 (G, UC, St); Bakersfield, Jones in 1924
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(Po); Castac Lake, Dudley & Lamb 4476a (Po, St); Tehachapi Mountains, Munz 8946 (Po); Banning, Jones in 1903 (Po); San Jacinto Mountains, Hall in 1899 (RM), 2028 (UC); Laguna Canyon, Munz 6599 (Po); near Bonsall, Munz & Harwood 3875 (Po, RM); Cuyamaca Lake, Munz 8941 (Po); Banner, Jones in 1906 (Po); Campo, Eastwood 9382 (Po, CA); Potrero Grade, Munz 9469 (Po); Rincon, Jaeger in 1925 (Po); La Jolla, Clements 128, 129 (G); San Diego, Spencer 1351 (G, CA, Po). LOWER CALIFORNIA: 15 mi. N. of Ensenada, Canby 142 (Po); Ensenada, Jones in 1882 (G), 3722 (Po, CA). ARIZONA: Congress Junction, Jones in 1903 (Po); Hillside, Jones in 1903 (Po); Wickenburg, Palmer 634 (type collection, G, UC); Sierra Tucson, Parish 189 (G, St); Ry, Jones in 1890 (Po), Coronado Forest, Eggleston 19820 (G); Santa Catalina Mountains, Pringle in 1881 (G), Thornber 477 (UC), Santa Rita Mountains, Thornber 478 (UC); Miami, Treakle in 1911 (Po).

The species purpurascens is so widespread that it varies considerably from one end of its range to the other. This variety is quite consistent in its showy purple spike found in the interior valleys. In the field it looks very different from the greener typicus of the coast. The line between these two varieties is rather artificial as we find them intermingling both in the Sacramento and upper San Joaquin Valleys as well as in southern California but I keep var. palmeri because it differentiates one large aggregate from the other. The form from the mountains of San Diego County is more bluish with large, deeply saccate corollas rather exserted from the spike but it can not be separated as a distinct variety. A specimen from Temescal Canyon, Riverside County, Munz 5031 (Po), approaches var. pallidus.

8e. Orthocarpus purpurascens var. pallidus, var. nov.

Orthocarpus exsertus Heller, Muhlenbergia 1:109, 1904. Lower lip of corolla yellow or white, never purple.

Type: Lincoln Park, near Pasadena, Los Angeles County, California, April 1902, Grant 886 (Stanford University). There is a co-type at UC.
Distribution: Santa Barbara to the borders of Riverside and Orange counties; occasional at San Diego. CALIFORNIA: Santa Maria, Munz 9286 (Po); 10 mi. E. of Lompoc, Munz & Keck 10310 (Po); Santa Barbara, Dexter in 1884 (G), Baker in 1886 (G), Eastwood 16 (G, UC), Munz & Keck 10323 (Po); Santa Cruz Island, Brandegee in 1888 (UC); E. of Ventura, Jones in 1926 (Po); Inglewood, Abrams 21006 (G, St); Lincoln Park, near Pasadena, Grant 6462 (Po, UC, St, RM, G); Claremont, Robinson 65, 80 (Po); Santa Cruz Island, Brandegee in 1888 (UC); E. of Ventura, Jones in 1926 (Po); Inglewood, Abrams 21006 (G, St); Lincoln Park, near Pasadena, Grant 6462 (Po, UC, St, RM, G); Claremont, Robinson 65, 80 (Po); Upland, Munz 2106 (Po); San Bernardino Valley, Parish 5883 (RM), 7073, 11142, (UC); San Bernardino, Cummings in 1896 (G); Anaheim, Baker 4132 (Po); San Diego, Spencer 1351 (Po); Chollas Valley, Orcutt 1018 (G).

This variety is distinct in the center of its distribution but on the northwest and south it approaches var. typicus and on the east it approaches var. palmeri. Specimens from Palm Springs, Hall 5761 (UC), appear to be forms of this variety. Heller's species, exsertus, is unsatisfactorily described for this material. The exserted corolla he emphasizes is not limited to the plants of this region. The white lower lip of the corolla is the outstanding character for the group. Heller's type collection has been retained as the type for this variety.


Erect, simple or branched above; stems 1.5-3.5 dm. high; herbage hirsute, more densely so above; leaves 2-5 cm. long, sessile, with 2 or 3 pairs of long linear lobes, green; spike dense, 3-8 cm. long; bracts 12-20 mm. long, nearly equaling the corolla, deeply cut by the slender lobes; calyx equaling bract, lobes slender much exceeding tube, bracts and calyx tipped with pale lilac-pink, the colored portions densely hirsute; corolla 15-25 mm. long, pubescent, tube white, lower lip yellow with two purple dots at base, galea lilac-pink, lower lip 3-saccate, sacs longer than deep, 4-6 mm. long, teeth small, erect, subulate, white, purple dot at base, galea exceeding lower lip by 2-3 mm., straight; anthers 2-celled, enclosed in
galea, glabrous, 1.5 mm. long; filaments naked; pistil glabrous, stigma exserted beyond tip of galea, globose or slightly 2-lobed, ca. 1 mm. in diameter; capsule ovate, 7-10 mm. long; seeds black, shiny, only half as large as the angled reticulate coat, 1 mm. long.

Distribution: Sierra Nevada foothills up to 5000 ft., Shasta County to Kern County, California. **Type locality:** in mountain pastures of the Sacramento region. **CALIFORNIA:** Sacramento Valley, *Hartweg 1903* (probably type collection, G); Anderson, Shasta County, *Smith in 1915* (CA); Auburn, *Sonne in 1891* (UC); New York Ravine, El Dorado County, *Brandegee in 1907* (UC, RM); Kelsey, *Jones in 1883* (Po); Clinton, Amador County, *Hansen 1651* (St); Indian Creek, Tuolumne County, *Ferris 1519* (St, CA); Mather, *Munz 7427* (Po, UC); Mariposa, *Congdon 75, in 1883* (G), 41 (St), *in 1893* (UC); Lewis, *Congdon in 1894* (UC), *in 1895* (G, UC), *in 1897* (St); Big Sandy Creek, Fresno County, *McDonald in 1916* (CA); Squaw Valley, *Jepson 2748* (UC); Kaweah River Basin, *Hopping 100, 287* (UC), *Woolsey in 1898* (UC); Milo, Tulare County, *Dudley in 1900* (St); Glenville, Kern County, *Weston 157* (CA).

A collection from Auburn, Placer County, *Ames in 1878* (G), appears to be this species approaching typical *O. densiflorus*.


A slender erect annual, usually unbranched or branching from the base, 1-3.5 dm. high; stems slender, pubescent; leaves sessile, linear-lanceolate, attenuate or with two lateral filiform lobes, pubescent, 2-6 cm. long; spike dense or more open below, 2-20 cm. long, green; bracts 15-20 mm. long, 3-lobed, each lobe two-thirds the total length of bract, stouter than calyx, white-tipped or with a purplish tinge in Tulare County material; calyx 20-23 mm. long exceeding tube of corolla, very pubescent toward the 4 subregular lobes,
6-8 mm. long, white-tipped; corolla white with prominent purple spots on the lower lip, pubescent, narrow throughout, 10-25 mm. long, lower lip shallow, 3-4 mm. long; teeth 1 mm. long, linear or obtuse; galea equaling teeth or exceeding them by not more than 1 mm., 4.5 mm. long, 3.5 mm. wide at base, subulate; longer pair of stamens syngenesious, anthers 0.5-1 mm. long, filaments free 3-4 mm., glabrous; pistil glabrous, stigma within galea, slightly two-lobed, less than 1 mm. wide; capsule elliptical, 6-10 mm. long, 3-5 mm. wide; seeds less than 1 mm. long, brown, smooth, in a loose-fitting reticulate coat.

Distribution: this common species is widely spread from British Columbia to southern California and adjacent Lower California, found along the coast and west of the Sierras. Type locality: Corte Madera, Marin County, California. BRITISH COLUMBIA: Vancouver Island, near Victoria, Anderson in 1903, in 1912, in 1924 (WS). WASHINGTON: Whidbey Island, Gardner 225 (WS, UC); American Lake, Flett 2123 (WS). OREGON: Salem, Nelson 2179 (G); Gold Beach, Curry County, Hoyt 69 (St); Grant's Pass, Heller 10019 (G, St). CALIFORNIA: Yreka, Butler 1314 (Po, RM, UC, St), Greene 786 (G); Eureka, Chandler 1141 (G, UC, St); Ukiah, Jones in 1924 (Po); Iron Canyon, Butte County, Bruce 2087 (Po); Auburn, Ames in 1895 (G); Mokelumne Hill, Calaveras County, Blaisdell (G, CA); Calistoga, Baker 1993 (RM, Po, G, UC); Corte Madera, Bigelow in 1854 (type, G); Stanford University, Baker 545 (Po, WS, RM, G, UC); Mariposa, Congdon in 1883 (St); Guernsey, Kings County, Eastwood 3907 (G, CA); Three Rivers, Abrams 10802 (Po, St); Bakersfield, Munz 9028 (Po); Keene Station, Heller 7817 (G, UC, St); Paso Robles, Barber 416 (UC); Morro Creek, Santa Lucía Mountains, Munz 9203 (Po); Santa Ynez Mountains, Elmer 3835 (Po, G, UC); Santa Barbara, Elmer 3835 (St); Cuyamaca Lake, Munz 9764 (Po); Campo, Parish 409 (G). LOWER CALIFORNIA: Hansen's Ranch, Orcutt 1131 (G); Santa Catalina Mountains, Orcutt in 1884 (UC).

This species shows the same peculiarity of range exhibited by O. densiflorus var. gracilis coming south as far as Santa
Barbara County along the coast and passing by the intervening territory to reappear in the mountains of San Diego County. (See discussion under *O. laciniatus*.)

11. **Orthocarpus laciniatus** (H. & A.), comb. nov.


Annual, erect or ascending, stems strict or branched, pilose, 1.5-2.5 dm. high; leaves linear or linear-lanceolate, lower entire, upper pinnatifid with 2-4 linear-filiform divisions, sparingly short-hispid, 1.5-3 cm. long; spike narrow, lax below; bracts 2-3 cm. long, lanceolate with 3-5 divaricate, linear, attenuate divisions, acute, green or with tips colored; calyx 1.5-2 cm. long, cleft halfway with 4 subregular, linear lobes, soft-pubescent; corolla purplish, narrow, 14-20 mm. long, lower lip shallowly 3-saccate, teeth 1.5 mm. long; oblong, erect, purple at base, galea exceeding lower lip 1.5-2 mm., purplish, slightly falcate and abruptly narrowed at tip, puberulent to pubescent on back, densely pubescent within, margins wide, scarious, glabrous; anthers 1.5 mm. long, glabrous, filaments ciliate, pistil included in the galea, stigma globose; capsule oval, 8-12 mm. long; seeds many with brown loose-fitting reticulate coats.

Distribution: Andes Mountains, Peru and Chile. *Type locality:* in the Andes of Peru at Huamontango (Mathews 4601). PERU: Huamontango, Mathew & Parker (G); Orbajillo, Wilkes in 1834-42 (G). CHILE: Santiago, (Brandegee Herbarium, UC).

Scarcely enough material was available of this species to accurately place its relationship. The collections that I have examined give but little clue as to the original color of the spikes or flowers. However, the species is apparently an inconspicuous one in the field. Its closest North American relative undoubtedly is *O. attenuatus*.

The oldest specific name for this material is *laciniatus* which, as *Castilleja laciniata*, Bentham reduced to synonymy under his species *australis*. The necessary new combination
was not discovered before the chart had been incorrectly printed as australis.

As this paper is in press, two collections of Orthocarpus from Chile come to me through the kindness of Dr. I. M. Johnston, of the Gray Herbarium. These plants seem identical with O. attenuatus and differ from the single sheet of laciniatus now at hand, namely, the one from Santiago. The latter plant has pinnatifid divisions to the leaves and bracts, red-violet corollas and stems, and the galea protrudes beyond the lower lip at least 2 mm. The specimens just received, however, have palmate lobing of the leaves and bracts, yellowish white corollas, and the galea does not exceed the teeth of the lower lip more than 1 mm. There are other minor differences that separate these so that laciniatus can not be referred to the species attenuatus. Possibly these two collections are of attenuatus that has been introduced into South America. The collections are: Chile: Ceno Cruz, Limache, Prov. Valparaiso, G. Looser 7 (G); Centinela, San Fernando Cerro, Prov. Colchagua, Montero 48 (G).


Stems erect, strict, usually simple or branching near the top, pubescent, 1-3.5 dm. high or a single specimen may be 6.5 dm. high; leaves of compact habit, sessile, linear or linear-lanceolate, pubescent, usually entire, dark green, 1.5-4 cm. long; spike more condensed than the leaves below, quite herbaceous, 1-25 cm. long; bracts 10-15 mm. long, 3-lobed, occasionally 5-lobed, the central lobe ovate or lanceolate-ovate, the small divergent lateral lobes ca. half the length of middle lobe, glandular-pubescent, dark green; calyx half as long as corolla, thin, glandular-pubescent, 6-8 mm. long, lobes sub-equal, acute, 2-3 mm. long; corolla golden-yellow, 10-12 mm. long, lower lip pubescent, simply saccate, not much larger than galea, 3.5-4 mm. long, 3 mm. wide, teeth minute, galea slightly glandular-pubescent, ca. 4 mm. long, ca. 4 mm. wide,
margins incurved and terminating in a minute hook, equaled by lower lip, obtuse; stamens paired, anthers pubescent, 2-celled, cells equal, boat-shaped, 1 mm. long; pistil inserted within galea, glabrous. stigma small only slightly wider than style; capsule elliptical, 5-7 mm. long, 3-4 mm. wide; seeds several, with tight-fitting yellow-brown reticulate wrinkled coats, 1-1.25 mm. long.

Distribution: the common yellow species of the Rocky Mountains and the most widespread found from 3500-9500 feet altitude and extending from the Canadian Rockies, to eastern Washington and California, into Arizona and New Mexico and northeast to the Dakotas. Type locality: “On the plains of the Missouri.” SASKATCHEWAN: Bourgeau (G). ALBERTA: Rosedale, Moodie 1070 (G, St): Banff, Prince in 1900 (G). BRITISH COLUMBIA: Comex District, Anderson 780 (WS). WASHINGTON: Usk, Kreager 359 (G, WS); Revere, Whitman County, Eastwood & St. John in 1925 (WS, Po). OREGON: Cycan Marsh, Cusick 2742 (WS, RM, UC, Po, G); Crater Lake, Coome in 1913 (G, CA). CALIFORNIA: Goose Lake Valley, Austin 537 (in part, Po); Vinton, Plumas County, Heller & Kennedy 8884 (G, St); near Sonora Pass, Mono County, Congdon in 1898 (UC). NEVADA: Deeth, Elko County, Heller 10559 (G, St); King’s Canyon, Ormsby County, Baker 1430 (Po, G, UC). IDAHO: Silver City, Macbride 431 (G, RM, WS); Picabo, Macbride & Payson 3019 (RM, St, G); Victor, Merrill & Wilcox 1235 (G, RM). UTAH: Park City, Jones 2149 (RM, Po); Pine Flats, Walker 351 (G, RM); Mendon, C. Piper Smith 1815 (RM, CA, St); La Sal Mountains, Purpus 7046 (Po, UC). ARIZONA: San Francisco Peak, MacDougal 377 (RM, G, UC); Flagstaff, Jones 3983 (Po, G). NEW MEXICO: Ft. Wingate, Mathews 46 (G); Mogallon Mountains, Socorro County, Metcalfe 530 (RM); Raton, Dichtl 352 (Po). COLORADO: Durango, Baker, Earle & Tracy 604 (RM, Po, G); Pagosa Springs, Baker 589 (WS, Po, G); Gunnison, Baker 563 (WS, G, Po, UC, RM); Grizzly Creek, Larimer County, Goodding 1872 (RM, G, UC, St). WYOMING: 15 mi. S. W. of Laramie, Merrill & Wilcox 1166 (RM, G); Boyd, Nelson 9440 (Po, St, G, RM); Sheridan. Nelson 8481
(RM); Yellowstone National Park, Nelson 6183 (G, Po, UC, St, RM, WS). MONTANA: Browning, Jones in 1909 (Po); Sedan, B. J. Jones in 1901 (G). SOUTH DAKOTA: Black Hills, Forzcood in 1887 (G); Bixby, Perkins County, Visher 622 (RM). NORTH DAKOTA: Leeds, Lunell in 1900 (G), in 1901 (RM), in 1902 (St); Dickinson, Holgate in 1908 (G); Svea, Fieldstad 420 (RM).


An erect branching annual with slender stems, puberulent, 1-3.5 dm. high; leaves sessile, linear, almost acuminate, puberulent, 1-4 cm. long; spike racemose, moderately compact, 2-10 cm. long; bracts 8-15 mm. long. 3-lobed, lateral lobes considerably smaller, divergent, narrowly lanceolate, central lobe lanceolate, glandular-pubescent, green; calyx half as long as corolla, lobes subequal, deltoid, 2-2.5 mm. long, calyx 6-8 mm. long; corolla yellow, 10-13 mm. long, lower lip simply saccate, glabrous, not much larger than galea, teeth inconspicuous, lip 4-5 mm. long; galea pubescent within, glabrous without, edges turned in, tip inflexed, cucullate, exceeding lower lip 1-2 mm., 4-5 mm. long, 3-4 mm. wide at base; stamens included in galea, filaments glabrous, free 4-5 mm., anthers boat-shaped, 1.25-1.75 mm. long, often ciliate; pistil included in corolla, stigma the slightly flattened tip of style; capsule glabrate, obovate, 3.5-7 mm. long; seeds few, plump. black-brown, 1.5-3 mm. long, coat tight-fitting, reticulate, ridged.

Distribution: this mountain species is much more restricted in range than the preceding being found at higher altitudes, 7500-10,500 feet, from southeastern Idaho to western Wyoming and Utah. Type locality: Snake Country. IDAHO: Montpelier, Nelson 9108, 9108a (RM). WYOMING: Evanston, Nelson 3838 (G, RM, CA); Teton Pass Mountains, Payson 2072 (G, CA, RM); Coal Creek, Teton Range, Hall 11442 (UC); Gros Ventre Mountains, Payson 3044 (G, RM); Big Piney, Payson 2610 (G, Po, UC, RM); Sheep Mountain, Payson & Armstrong 3443 (RM); Red Mountain,


Stems erect, simple or branching above, glandular-pubescent, purplish, 1-4 dm. high; leaves filiform or linear, sessile, alternate, glandular-pubescent, 1.5-3.5 cm. long, simple or 3-lobed, lateral lobes equaling mid-lobe, green; spike loose, few- to many-flowered, herbaceous, 3-25 cm. long; lower bracts equaling corolla, 10-20 mm. long, 3-lobed from near the base, lateral lobes nearly equaling mid-lobe, glandular-pubescent, green; calyx less than half the length of tube of corolla, glandular-pubescent, 7-9 mm. long, lobes sub-regular, prominent green stripe down middle of each lobe, margins scarious, acute; corolla white or purplish, well exserted, 15-20 mm. long, tube nearly twice as long as lower lip, pubescent, lower lip simply saccate, thin, expanding from throat, much larger than galea, glabrous, 7-9 mm. long, 4-5 mm. across, no teeth; galea exceeding lower lip ca. 1 mm., strongly pubescent margins, tip inflexed, uncinate; anthers 1.5-2 mm. long, cells boat-shaped, ciliate, filaments glabrous, free 5-6 mm.; pistil included in galea, very short, slightly exceeding throat, style 11-15 mm. long, stigma but slightly wider than style, small; capsule narrowly elliptical, 5-7 mm. long; seeds 8-10, rather close-fitting alveolar coat, angled, 2-2.5 mm. long.

Distribution: found in the Rocky Mountains up to 9500 ft. Colorado to northern New Mexico and Arizona. Type lo-

Erect slender stems, simple or branching above, pubescent, somewhat glandular, yellow, brown or purplish, 1-4 dm. high; leaves linear to lancelolate, 1.5-3.5 cm. long, green, glandular-pubescent, entire below, divided with two lateral lobes above, lobes linear-lanceolate; spike compact, blooming rather apically, 2-15 cm. long; bracts obtuse or rounded at base, green or tinged with purple, 10-20 mm. long, divided two-thirds of the way down by 2 or 4 lanceolate divaricate lobes, central lobe exceeding lateral lobes, widely lanceolate, acute, glandular-pubescent with soft hairs; calyx green, glandular-pubescent with long soft hairs, 6-10 mm. long; split half way down each side, these segments again cleft into acuminate lobes 2-4 mm. long; corolla white, pinkish lavender or bright purple, well exserted from the spike, 12-20 mm. long, tube longer than calyx, gradually swelling out into lower lip, lower lip covered with short, fine hair, simply saccate, no teeth, 5-7 mm. long; galea wide, scarcely exceeding lower lip, strongly pubescent, tip inflexed with inrolling, papery beak, 4-6 mm. long; anthers olive-green, boat-shaped with strongly inrolling margins, ciliate, anthers ca. 1.5 mm. long, filaments glabrous, 5-7 mm. long; pistil included in galea, stigma small,
less than 0.5 mm. in diameter; capsule brown, elliptical, 5-7 mm. long; seeds few, 2-3 mm. long, reticulated coat prominently ridged, not alveolar.

A. Flowers rose-purple..........................15a. var. typicus
AA. Flowers white................................15b. var. albus

15a. **Orthocarpus bracteosus** var. **typicus**, nom. nov.


Distribution: this plant with deep-pink flowers is one of the most beautiful species. It is a valley inhabitant ranging from Vancouver Island, B. C., to northern California. *Type locality:* Columbia River. BRITISH COLUMBIA: Vancouver Island, Kellogg 9 (G), Diehl in 1902 (Po); Oak Bay, Anderson in 1894 (WS), Diehl 163 (Po); Victoria, Macoun 724 (G), Henry in 1911 (RM), Fletcher in 1885 (G). WASHINGTON: San Juan Island, Roush in 1919 (St); Falcon Valley, Suksdorf in 1883 (St). OREGON: Salem, Nelson 1617 (G), 252 (St); Monmouth, Spillman 152 (WS); Willamette Valley, Cusick 1497 (WS); Corvallis, Gilkey in 1911 (RM), Abrams 8726 (Po, St); Monroe, Munz 9898 (Po); Des Chutes River, Leiberg 595 (G, UC); Cycan Marsh, Cusick 2743 (Po, G, UC, WS, RM); Calapooya Valley, Barber in 1899 (RM, G); Silver Creek Falls, Nelson 2246 (G); Klamath Valley, Cronkrite in 1864 (G); Upper Klamath Lake, Peck 7853 (G); Aspen Lake, Copeland 3477 (G, Po, CA, UC, RM); Ft. Klamath, Leiberg 661 (G, UC). CALIFORNIA: Upton, Copeland 3897 (Po, CA, G); north-eastern Modoc County, Manning 495 (UC); Plumus County, Lemmon in 1875 (G).

15b. **Orthocarpus bracteosus** var. **albus**, var. nov.

Corolla white, stems yellow, herbage with yellowish cast, otherwise as var. typicus.

*Type:* Big Meadows, Des Chutes River, Oregon, July 26, 1894, *J. B. Leiberg 521* (Gray Hb.) Co-types at UC and CA.


Slender, simple or with erect branches, hirsute-pubescent, 1.5-3 dm. high; leaves 1-5 cm. long, linear with 2 or 4 divergent linear lobes, finely pubescent, somewhat ciliate below; spike dense, heavy, cylindric, 2-6 cm. long; bracts 10-20 mm. long, with 2 or 4 attenuate lateral lobes, middle lobe elliptical or ovate, obtuse or rounded, lower margin strongly ciliate with white flattened hairs, purplish tipped; calyx 7-12 mm. long, deeply cleft, the lobes shallowly 2-cleft, ciliate; corolla yellow or purplish at apex, pubescent, 14-20 mm. long, tube exceeding calyx, lower lip rather shallow, simply saccate, finely pubescent, teeth inconspicuous; galea exceeding lower lip ca. 1 mm., pubescent to the tip which is strongly inflexed; anther-cells boat-shaped, ciliate, anthers ca. 2 mm. long, filaments glabrous, free 6-7 mm.; style slightly scabrous-puberulent, more marked below, stigma small; capsule elliptical, brown, puberulent toward the tip, 5-9 mm. long; seeds several to many (29 ripe seeds in average one counted), ca. 1 mm. long, tight-fitting reticulate coat strongly ridged.

Distribution: a common species found at middle altitudes from Montana to eastern Washington and Oregon. Type locality: on the banks of Clark's River. MONTANA: Bozeman, Moore in 1900 (Po, UC, St, RM); Helena, Kelsey in 1891 (Po); Phillipsburg, Titcomb in 1884 (G); Flathead Lake, Elrod in 1907 (Po, St), Jones in 1908 (Po); Ravalli, Jones in 1909 (Po); Upper Marias Pass, Jones in 1909 (Po); Big Hole Valley, Watson in 1880 (G). IDAHO: Tamarack, Clark 170 (G, St, RM); Moscow, Abrams 744 (Po, UC, St); Lake Coeur d'Alene, Aiton in 1892 (RM, Po). WASHINGTON: Omak Lake, St. John 3535 (WS, Po); Grand Coulee,
Douglas County, *Cotton 618* (WS); Yakima Region, *Brandegge in 1882* (UC); scab lands, Adams County, *St. John & Eastwood 13255, 13255a* (WS, CA, Po); Clark's Springs, *Kreager 18* (WS, G); Spokane, *Dewart* (WS); Rocklake, *Beattie & Lawrence 2348* (WS); Pullman, *Piper 1666* (WS, G), *Elmer 168* (RM, Po). OREGON: Colea Creek, Wallows County, *Sheldon 8265* (RM); Union, *Cusick 89* (G); Meacham, *Peck 5804* (G); Austin Ranch, E. Grant County, *Henderson 5678* (St); 5 mi. S. of Grass Valley, Sherman County, *Lawrence 375* (St).


Slender, erect, simple or with several erect branches, pilose, 8-25 cm. high; leaves 2-4 cm. long, scabrous-pubescent, entire or deeply 3- or 5-cleft with linear-attenuate lobes; spike closely imbricated, yellowish green, flowers 1.5-3 cm. long, nearly concealed by the bracts; bracts papery, ovate, acute, scabrate-puberulent, ciliate-margined, 10-18 mm. long, 5-12 mm. wide, 3- or 5-cleft with linear-lanceolate attenuate lobes; calyx 2-parted, its lobes cleft into 2 linear attenuate teeth *ca. 4 mm. long*, ciliate, becoming scabrous-puberulent on the teeth, 8-9 mm. long; corolla yellow, 10-12 mm. long, throat equalled by teeth of calyx, rather small lower lip nearly glabrous except for the pubescent margin, 4 mm. long, teeth 0.5 mm. long or less; galea straight, narrow, bearded at tip, extending beyond lower lip *ca. 1.5 mm.*; anther-cells elliptical, ciliate, upper cell of pair slightly larger, filaments glabrous, free 4 mm.; style glabrous, 6 mm. long, stigma small; capsule yellow-brown, ovate, acute at tip, scabrate-puberulent, 6-10 mm. long; seeds several, 8 mm. long with a yellow tight-fitting alveolar coat.

Distribution: a rare plant restricted to a small area in central Washington. *Type locality:* near Crab and Wilson Creeks, Douglas County. (This region is now included in Grant County.) WASHINGTON: near Crab and Wilson Creeks, Douglas County, *Sandberg & Leiberg 234* (Type col-
lection, G, UC); Wilson Creek, Sandberg & Leiberg in 1893 (WS); east of Moses Lake, Cotton 613 (WS); Soap Lake, Grant County, St. John, Courtney, Parker 5000 (WS, UC).


Stems erect, stout, simple or branching midway, 1.5-3 dm. high, pubescent with short appressed hairs; leaves linear-lanceolate, 1-4 cm. long, usually parted to below the middle with 3 linear-attenuate lobes, scabrate-puberulent; spike heavy, cylindric, compact, closely imbricated, 2-15 cm. long; bracts abruptly differing from the leaves, broadly ovate below with a pair of divericate attenuate teeth, above broadly oval, nearly truncate, entire, sparsely ciliate-margined at base, otherwise nearly glabrous, purple and chartaceous, 12-20 mm. long, 8-12 mm. wide; calyx 8-12 mm. long, deeply parted into two lobes which are again cleft half way into two attenuate teeth, 4-5 mm. long, ciliate, papery below; corolla rose-purple with white or yellowish lower lip, much exceeding bracts, 20-25 mm. long, tube glabrous. wide, 5-6 mm. long, expanding into the much inflated lower lip which is 6-7 mm. long, 3-4 mm. deep, glabrate, the 3 narrow teeth 1 mm. long; galea arching, 10-12 mm. long, 5 mm. wide, exceeding lower lip 3-5 mm., puberulent, tip decidedly pubescent, 1 mm. deep; anthers 3-3.5 mm. long, cells boat-shaped, ciliate, filaments glabrous, free 10 mm.; style finely pubescent, extending to tip of galea, stigma inconspicuous; capsule ellipsoidal, 6-8 mm. long, brown; seeds black, few, 2 mm. long, with a tight-fitting alveolar coat.

Distribution: infrequent at middle altitudes in the Siskiyou Mountains of southern Oregon and California. Type locality: Ashland Butte, Siskiyou Mountains, southern Oregon. OREGON: Grizzly Peak, Jackson County, Peck 5809 (Herb. of Willamette Univ.) ; Shake, Austin 239 (UC); Ashland Butte, Howell in 1887 (type collection, UC); Keno, Klamath County, Peck 9373 (Herb. of Willamette Univ.), 9376 (G).

June 11, 1927
CALIFORNIA: Siskiyou Mountains, Henderson 19 (G, St), 780 (UC, CA); Goosenest Foothills, Butler 930 (Po, St, UC), 1584 (Po, RM, UC, St).


Stems 1-3.5 dm. high, slender, simple or with several ascending branches above, purplish, covered with a short weak pubescence; leaves linear-lanceolate, 1-6 cm. long, entire below, cleft half way by two short attenuate teeth above, puberulent; spike compact, cylindrical, shortened often to a head, 1-9 cm. long; bracts similar to those in preceding species, 8-14 mm. long, 5-10 mm. wide; calyx as in O. cuspidatus with teeth 1.5-3 mm. long; corolla 10-15 mm. long, rose-purple with lower lip white or yellowish, tube glabrous rapidly expanding into throat, lower lip inflated, 4-6 mm. long, 2-4 mm. deep, glabrous without except on the inconspicuous teeth; galea 4-6 mm. long, 4-5 mm. wide at base, scarcely exceeding lower lip, pubescent without, straight; anthers 1.5-2.5 mm. long, cells boat-shaped, ciliate, filaments glabrous or pubescent, free 4-7 mm.; style pubescent near base, stigma inconspicuous, enclosed in galea; capsule elliptical, brown, 5-7 mm. long; seeds few to several, ca. 2 mm. long with tight-fitting compressed alveolar coat.

A. Lower lip of corolla 3-4 mm. deep; spike usually crowded into a head; flowers extending well beyond the herbaceous bracts......................19a. var. typicus

AA. Lower lip of corolla 2 mm. deep; spike elongated; flowers nearly hidden by the chartaceous bracts

..........................19b. var. cryptanthus

19a. Orthocarpus copelandi var. typicus, nom. nov.


Spike usually crowded into a head, flowers often divergent, extending well beyond the herbaceous bracts; bracts ca.
10 mm. long, 5 mm. wide. (Jones in 1897 from Susanville, bracts 12 mm. long, 10 mm. wide); corolla 12-15 mm. long, lower lip 3-4 mm. deep; galea pubescent along groove within.

Distribution: a mountainous species from Josephine County, Oregon, south and east to Plumas and Lassen counties, California. Type locality: Mt. Eddy, altitude 7000 feet, Siskiyou County, California. OREGON: S. E. of Oregon Caves, Peck 8376 (G, Herb. of Willamette Univ.). CALIFORNIA: Dorleska, Salmon Mountains, Hall 8590 (Po, UC, G, RM, St); Salmon Creek, Dudley in 1901 (St); Salmon River, Alexander & Kellogg 256 (UC); Shackleford Creek, Butler 1680 (Po, St, UC, RM), 53 (St, UC); Mt. Eddy, Copeland in 1903 (type, CA), Eastwood 1965 (CA, G), Heller 12098 (G, St, CA), Smith 537 (CA); Scott Mountains, Greene 986 (G); N. side Mt. Shasta, Brown 449 (UC, CA); head waters of the Sacramento River, Pringle 88 (G, CA); Susanville, Jones in 1897 (Po, CA); Red Clover Valley, Heller & Kennedy 8700 (G, St).

19b. *Orthocarpus copelandi* var. *cryptanthus* (Piper), comb. nov.


Spike elongated, flowers nearly hidden by the closely imbricated chartaceous bracts; bracts 10-15 mm. long, 6-10 mm. wide; corolla 10-12 mm. long, lower lip 2 mm. deep; galea puberulent or glabrous along groove within.

Distribution: found above 4000 ft. from southeastern Oregon to the Yosemite National Park, California. Type locality: Stein Mountains, near Wild Horse Creek, Oregon. OREGON: Stein Mountains, near Wild Horse Creek, Cusick 2035 (type collection, WS, UC, RM, G); Stein Mountains, opposite Andrews, Leiberg 2531 (G, Po, UC). CALIFORNIA: Modoc County, Gilman 560 (UC); Parker Creek, Modoc County, Ferris & Duthie 93 (St); Mt. Bidwell, Manning 286 (UC); Lassen Peak, Lemmon in 1873 (G); Lassen County, Austin in 1879 (G), Stephens in 1894 (UC); Lake Canter Camp, Feather River, Gillin 1921 (CA) Summit,
Brandegee in 1883 (UC), in 1888 (St), Greene 476 (G); Donner Lake, Heller 6884 (Po, G, RM, UC, St); Soda Springs, Jones 2603 (Po); Placer County, Carpenter in 1892 (UC), Sonne 277 (St), in 1884, in 1887 (UC); Inspiration Point, Nevada County, Dudley in 1894 (St); Truckee, Sonne 402 (UC); Donner Lake, Heller 6884 (Po, G, RM, UC, St); Soda Springs, Jones 260J (Po); Placer County, Carpenter in 1892 (UC), Sonne 277 (St), in 1884, in 1887 (UC); Inspiration Point, Nevada County, Dudley in 1894 (St); Truckee, Sonne 402 (UC); Deer Park, Lake Tahoe region, Eastwood 255 (G, CA); Tahoe City, Kelley in 1923 (CA); Alpine County, Hansen 455 (UC, St); Lundy, Mono County, Congdon in 1894 (G, St), Minthorn in 1908 (UC); Farrington's, near Mono Lake, Eastwood in 1907 (CA); Piute Creek, Yosemite Park, Reed 3462 (UC); Plateau above Muir Gorge, Jepson 3385 (UC). NEVADA: Hunter Creek, Washoe County, Kennedy 1611 (St, UC).

This species with its two varieties is very distinct from O. cuspidatus, with which it is most often confused, in having a corolla only 10-15 mm. long with a straight galea scarcely exceeding the lower lip as compared with the corolla 20-25 mm. long with the curved galea exceeding the lower lip by 3-5 mm. of O. cuspidatus. These two species, however, are certainly very closely related being similar in range, habit, flower color, bracts and other characteristics.


Small stout annual, stems simple or branching above, glandular-pubescent, 1.5-2.5 dm. high; leaves 1.5-3.5 cm. long, linear, entire or 3-5 linear-lobed, scabrous-puberulent; spike heavy, compact, flowers slightly extending from the closely imbricated bracts, 2.5-10 cm. long; bracts abruptly differing from the leaves, 3-5-7-lobed, 15-28 mm. long, rose-purple, middle lobe oblong-ovate, tip acute below or rounded above, 5-9 mm. wide, lateral lobes divergent, lanceolate, half as long as middle lobe, 8-15 mm. long, finely scabrous-puberulent or ciliate toward the base; calyx 15-20 mm. long, parted nearly to base in front, less than half way behind, each lobe bearing two lanceolate teeth 5-6 mm. long, puberulent, somewhat ciliate; corolla rose-purple, 20-30 mm. long, tube exceeding calyx, lower lip nearly glabrous except margins and rounded teeth
which are pubescent, galea exceeding lower lip 2-3 mm., incurved tip conspicuous, slender, glabrous or nearly so; anther-cells ca. 2 mm. long, narrow, curved, glabrous, filaments glabrous; style scabrous-puberulent, stigma small; capsule elliptical, yellow-brown, 5-7 mm. long; seeds several with tight-fitting finely alveolar coat, flattened, 3 mm. long.

Distribution: a rare plant of Siskiyou County, California. Type locality: plains of the shasta River. Siskiyou County: near Yreka, Greene 813 (type collection, G, CA, UC); Gazelle, Smith 267 (G, CA).


Erect, slender, simple or corymosely branching above, stems puberulent, 2-3.4 dm. high; leaves linear or lanceolate, clasping the stem at base, glabrous or especially the margins finely puberulent, entire, 1-4 cm. long; spike short, compact, 1-4 cm. long; bracts abruptly differing from the leaves, entire or with two small lateral attenuate lobes below the middle, ovate or oblong, obtuse, rounded or with a small mucronate tip, finely puberulent, lower margins soft-ciliate, green, tipped with purple, 7-14 mm. long, 4-7 mm. wide; calyx 4-6 mm. long, deeply cleft before and behind, each lobe with two attenuate teeth ca. 1.5 mm. long, pubescent, scarious, green ribs; corolla purplish, partially concealed by bracts, 10-13 mm. long, tube twice as long as calyx, gradually expanding into throat, lower lip whitish, pubescent, 3-4 mm. long, simply saccate or 3-plicate, teeth small, narrowly deltoid, 1.5 mm. apart; galea triangular, exceeding lower lip ca. 1 mm., puberulent, margins inrolling, uncinate, ending in a scarious tube; anther cells ca. equal, boat-shaped, ciliate, anthers 1.5 mm. long, filaments glabrous; pistil included, style scabrous-puberulent, stigma the slightly expanded tip of style; capsule oval, flattened; seeds few to several, tight-fitting reticulate coat, 2 mm. long.
Distribution: this rather uncommon species occurs in the mountains from Washington to northern California. The center of distribution is in California. *Type locality:* Cascade Mountains, Oregon. WASHINGTON: Olympic Mountains, Clallam County, Flett 85 (WS), Elmer 2574 (type collection for *O. olympicus*, St, WS, CA). OREGON: Cascade Mountains, Newberry (type collection, G), *Rose 215, in 1909* (St); Smith River, Linn County, Sheldon St2661 (St); 18 mi. W. of Crater Lake, *Peck 5769* (G); Buck Lake, Applegate 389 (G). CALIFORNIA: Ager, Siskiyou County, *Furlong in 1901* (UC); Mt. Shasta, Palmer 2435 (Po), Congdon in 1900 (UC); McCloud, Eastwood 1066 (G, CA), Condit in 1911 (UC); between Bigelow’s and McCloud River, Eastwood 10855 (CA); Nabar, Del Norte County, *Dudley in 1899* (St); Tamarack Road, Shasta County, Baker 349 (UC); Trinity Summit, Manning in 1899 (UC); Redwood Creek, Humboldt County, *Chesnut & Drew in 1888* (UC).

22. **Orthocarpus erianthus** Benth., Scroph. Ind., 12, 1835.

Stems simple or more commonly with many branches, divergent above, divaricate or ascending below, puberulent or with short glandular pubescence, 0.5-3.5 dm. high; leaves 1-5 cm. long, linear, clasping stem at base, pinnately divided toward tip with many filiform divisions, glabrous or glandular-pubescent; spike 2-15 cm. long, more compact above, corollas well exserted; bracts 5-18 mm. long, usually half the length of corolla or below equaling the corolla, glabrous to glandular-pubescent, divided into 4-10 linear divisions; calyx 5-8 mm. long, pubescent, 4 subregular lanceolate teeth; corolla 10-25 mm. long, tube long, slender, densely pubescent, lower lip abrupt, prominently 3-saccate, glabrous without, bearded within; galea red-purple, equaling or slightly exceeding lower lip, narrow, subulate, straight or curved; anthers coherent in pairs, cells shallow; pistil glabrous, stigma ca. equaling galea; capsule 4-8 mm. long, oblong, brown; seeds many, with reticulate coats.
A. Lower lip 3-5 mm. deep.
   B. Corolla at least partly yellow, lower lip 3-4 mm. deep.
   C. Lower lip yellow.................................22a. var. typicus
   CC. Lower lip with two lateral sacs white, the middle one yellow..........22b. var. gratiosus
   BB. Corolla white turning rose-pink, lower lip 4-5 mm. deep ................22c. var. roseus
   AA. Lower lip 2 mm. deep.........................22d. var. micranthus

22a. Orthocarpus erianthus var. typicus, nom. nov.


Herbage pubescent; corolla conspicuous, galea slightly curved, purple, lower lip yellow with a purple band around the throat, 3-4 mm. deep.

Distribution: a plant of the fields occurring commonly from the upper Sacramento Valley to Tulare County and from Del Norte County to San Luis Obispo County; occurring rarely in southern California. Type locality: probably near Monterey. CALIFORNIA: Douglas (probably type collection, G); Adams Stations, Del Norte County, Eastwood 131 (CA); Humboldt County, Marshall in 1888 (UC); Redding, Baker 24 (UC); Red Bluff, Jones 244 (G); Chico, Copeland 3036 (Po, UC, CA, RM, G), Bidwell in 1878 (type for O. bidwelliae, G); Marysville, Heller 7566 (G, St, UC); Auburn, Ames in 1891 (Po, UC, G); Ione, Eastwood 10068 (CA, G); Potter Valley, Purpus 3093 (UC); Clear Lake, Peirson 6587 (Po); Santa Rosa, Heller & Brown 5219 (RM, G, Po, St); Vallejo, Greene 110 (G); Stockton, Sanford 166 (UC); Livermore, Heller 7315 (RM, G, St, UC); Palo Alto Stock Farm, Burnham in 1894 (Po); Mt. Hamilton, Baker 633 (Po, G, WS, UC, CA); Santa Cruz, Elmer 4491 (Po, CA, UC, St); Fremont's Peak, San Juan, Elmer 4906 (Po, CA, St); Jolon, Eastwood 4079 (CA); San Luis Obispo, Munz 9235 (Po); Arroyo Grande, Brewer 437 (G, UC); Mariposa County, Eastwood 4262 (G, CA); Lindsay, Munz 9042 (Po);
Ventura County, collector unknown (St); Tejunga, Los Angeles County, *Wilder* (St); Foster’s, San Diego County, Brandegee in 1906 (UC).

In the springtime typical *O. erianthus* often brightens entire fields with yellow. This species and *O. purpurascens* are the two most plentiful in California. This variety is replaced for the most part by others along the coast. It has been introduced into Washington: West Seattle, *Piper 552* (G). The material from the Sacramento Valley, which Gray named *O. bidwelliae*, can not be separated from that of the Coast Ranges. The looseness of the seed coat, size of corolla, and pubescence, which were Gray’s distinguishing characters, are variable.


Lower lip of corolla with middle lobe yellow, two lateral lobes white, purple band prominent about throat.

Distribution: coastal, Curry County, Oregon and Humboldt County, California. *Type locality*: Eureka. OREGON: Port Orford, Peck 8477 (G); Gold Beach, *Abrams & Benson 10666* (St). CALIFORNIA: Humboldt Bay region, Tracy 2019 (RM, G, St), 2040 (UC), Chandler 1142 (G, St, UC), Jones in 1924 (Po), Hutchinson in 1913 (CA), Bohmannson in 1907 (CA); Kneeland Prairie, Tracy 2477 (UC).

In the older herbarium specimens of this variety the lower lip appears uniform in color. In the field the plants are decidedly distinct from var. *typicus*. The Oregon material cited above appears to be this variety although the color of each sac of the lower lip was not discernible. A sheet from Eureka, Tracy 2035 (UC), which is given as the type number, is undoubtedly a hybrid between this variety and *O. pusillus*. Jepson has told me that the type sheet for var. *gratiosus* was Tracy 2035 in the U. C. Herbarium. This is certainly an error in citation for Tracy distinctly labels this sheet as a hybrid between var. *gratiosus* and *O. pusillus*. 


Lower lip of corolla rose-pink or white turning rose-pink, 4-5 mm. deep. Otherwise as var. *typicus*.

Distribution: the common form near the ocean from Mendocino County to San Benito County, California; occasional to Del Norte County. Type locality: Port Bodega, Sonoma County. CALIFORNIA: Gasquet, Del Norte County, Howell 1469, 1470 (UC); Noyo, Bolander 4722 (UC, G); Mendocino, Brown 700 (type for *O. erianthus* var. *inopinus*, UC); near Stewart’s Point, Baker in 1898 (UC); Bodega Bay, Wrangell (G); Bodega Point, Eastwood in 1899 (RM, G), 4858 (G, CA); San Francisco County, Babcock in 1902 (Po, RM, St); South San Francisco, Elmer 4670 (Po, St, UC, CA); San Bruno Hills, Baker 1896 (G, UC, CA, Po, RM); Aromas, San Benito County, Eastwood 4188 (G, CA).

All gradations occur between the larger plants with white flowers which later turn pink and the smaller ones which produce pink flowers.


Herbage pubescent; corolla 8-15 mm. long, lower lip ca. 2 mm. deep, yellow; stamens exserted from galea, separate.

* Jepson reduced Greene’s species *micranthus* to varietal rank under *erianthus*. Examination of the type of *bidwelliae* var. *micranthus* Gray shows it to be the same as Greene’s type. Since Gray’s name has priority the variety is accredited as (Gray) Jepson.
Distribution: open fields, Mariposa County to Tulare County, west to eastern Monterey County, California. *Type locality:* plains of Fresno County. Danah Road, Mariposa County, *Congdon in 1889* (G, St); Snow Creek Road, *Congdon in 1886* (G); Mariposa County, *Congdon in 1889* (G); Pollasky, *Heller 8169* (type collection for *O. micranthus*, G, St, UC, CA); plains of Fresno County, *Green in 1884* (type collection, G, UC); Big Sandy Creek, Fresno County, *McDonald in 1915* (CA); Priest Valley, Monterey County, *Eastwood in 1893* (UC); Jolon, *Eastwood 4086* (G, CA); Santa Lucia Mountains, *Ferris 1802* (St); Badger Road, Tulare County, *Kelley in 1919* (UC); Three Rivers, *Abrams 10799* (Po); Lindsay, *Munz 9043* (Po); Porterville, *Kelley in 1922* (CA); Richgrove, *Munz 9013* (Po).


Stems 1-4.5 (-6) dm. high, simple or usually corymbose branched, straw-colored, glabrous or nearly so to the inflorescence where they become puberulent; leaves 2-8 cm. long; bracts and calyx similar to those of the preceding species; corolla clear yellow or whitish often fading pinkish, galea lighter than in the preceding, yellowish on the ridge becoming purple toward the margins, lower lip yellow or white with 6-12 purple dots on each margin, tube slender, densely pubescent, lower lip varies from 2-4 mm. deep, bearded within, teeth less than 1 mm. long; other characters similar to those of the preceding species.

Distribution: coastal valleys from southern Oregon to Monterey County, California. *Type locality:* Corte Madera, Marin County, California. OREGON: between Bandon and Langlois, *Abrams & Benson 10635* (RM, St). CALIFORNIA: Crescent City, *Howell 1469* (RM); Trinidad, *Tracy 3237* (UC); Humboldt Bay, *Chandler 1101* (G, UC,
St); Noyo, Bolander 6537 (G, UC); Willits, Jones in 1924 (Po); Fort Ross, Heller 6607 (G, Po, RM, UC, St); Calistoga, Baker 2632 (Po, CA, G, UC); Santa Rosa, Heller & Brown 5292 (Po, RM, G, St); Vallejo, Greene 379 (G); Lagunitas, Eastwood 42 (G); Corte Madera, Bigelow in 1854 (type, G), Heller 7365 (RM, G, St, UC); San Francisco, Jones 3267 (Po, CA, RM); Mission Hills, Bolander 6301 (G); W. of Watsonville, Baker 1955 (Po, UC, CA, RM, G); Castroville, Elmer 4474 (Po, CA, St).

Gray, who first described this species, later reduced it to a variety under O. erianthus. Indeed this plant is closely related to erianthus, but here it is retained as a separate species because it differs in several specific characters, whereas the varieties of erianthus here recognized are based upon fewer differences. The two species most closely approach each other through O. erianthus var. roseus. In British Columbia, where this species has probably been an introduction, it approaches that variety. The British Columbia plants are smaller than the California material: Victoria, Henry 6501 (RM); Oak Bay, Vancouver Island, Anderson in 1896 (WS), Macoun 87709 (G), Gardner in 1901 (UC).


A slender plant, 4-20 cm. high, with many weak ascending branches from the base, main stem obscure, herbage hispidulous-pubescent, with a purplish cast; leaves linear, 10-30 mm. long, with 2-8 lateral filiform divisions; spike elongated, often flowering from base of stem, flowers scattered; bracts 5-12 mm. long, once or twice pinnatifid with 3-7 filiform divisions, exceeding the flowers; calyx 5-7 mm. long with 4 subequal attenuate teeth, becoming papery on the fruit; corolla red-purple, occasionally yellow, 4-6 mm. long, inconspicuous, early shed off expanding ovary, tube yellowish, glabrous, lower lip nearly glabrous, 1.5-2 mm. long, shallow, trisaccate, teeth inconspicuous; galea uncinate, exceeding lower lip 0.5 mm., sparingly pubescent; anthers early exserted from galea, 0.5 mm. long, somewhat pubescent, filaments free
1-1.5 mm.; style glabrous, stigma capitate; capsule 4-6 mm. long, subspherical, flattened, light brown; seeds many, black, with tight-fitting reticulate coat.

A. Herbage deep green becoming purplish .................. 24a. var. typicus
AA. Herbage a bright yellow-green, not at all purplish

24a. Orthocarpus pusillus var. typicus, nom. nov.


Herbage deep green becoming purplish, often giving a purplish cast to the grassy places where it grows.

Distribution: British Columbia to San Luis Obispo County, California. Type locality: probably near San Francisco or Monterey, California. BRITISH COLUMBIA: Cedar Hill, Anderson 690 (WS); Cowichan Lake, Anderson 691 (WS); Victoria, Henry 6500 (RM, CA). WASHINGTON: Prairie, Flett in 1896 (WS); Seattle, Piper in 1892 (G, WS); Port Townsend, Elmer 2592 (WS, Po, St); Westport, Grant in 1919 (G); Montesano, Heller 3877 (WS, G, UC, RM). OREGON: Portland, Sheldon in 1902 (Po, G, St, WS); Salem, Nelson 2161, 1074 (G); Sauvies Island, Howell in 1876 (Po), in 1893 (RM, UC); Cow Creek, Douglas County, Abrams & Benson 10468 (St); Port Orford, Peck 9064 (G); Grant’s Pass, Prescott in 1912 (G, St). CALIFORNIA: Douglas (probably type collection, G); Eureka, Tracy 2166 (G, UC), 2167 (UC); Cherokee Mine, Butte County, Heller 13106 (G, CA); Auburn, Ames in 1895, in 1886, in 1891 (G); Sacramento, Baker in 1900 (UC); Mokelumne Hill, Calaveras County, Blaisdell (G, CA); Ukiah, Jones in 1924 (Po); Bennett Valley, S. E. of Santa Rosa, Heller & Brown 5250 (Po, St, G, RM); Fairfax, Michener & Bioletti in 1892 (RM, St, UC); Mt. Diablo, Chandler 945 (Po, UC); San Francisco, Heller 8490 (G, St); Stanford University, Baker 498 (Po, WS, UC, RM, G); Castrovile, Heller 8490 (G, St); 10 mi. E. of Morro, Munz & Keck 10203 (Po).
This plant seems undoubtedly to hybridize with *O. erianthus*. One of these apparent hybrids is from Navarro, Mendocino County, *Byxbee in 1895* (UC). (See discussion under *O. erianthus* var. *gratiosus*.)

24b. *Orthocarpus pusillus* var. *densiusculus* (Gdgr.), comb. nov.


Herbage distinctly yellow-green, otherwise as var. *typicus*.

Type collection the only material seen, taken on dry low ground, Bingen, W. Klickitat County, Washington, *Suksdorf 5015* (WS, St).


Stems erect, 1-3 dm. high, corymbose branched from near the base, yellowish brown, sparingly pubescent; leaves 10-40 mm. long, pinnate above with many filiform divisions, nearly glabrous; spike compact, short, 1-5 (-10) cm. long; bracts 4-12 mm. long, pinnately 3-7 parted with linear attenuate lobes, scabridulus-puberulent, equaling tube of corolla below, only equaling calyx above; calyx 4-6 mm. long, cleft half way into two lobes, each lobe again cleft into a pair of acute teeth, usually glabrous except for scabridulus margins of teeth; corolla white or cream-colored, 10-14 mm. long, glabrous except for beard within lower lip, tube twice as long as calyx, lower lip with 3 divergent oblong sacs 2 mm. deep; galea equaling lower lip before the sacs reflex, papery, expanded, obtuse, slightly reflexed; stamens exserted from galea extending beyond its tip, anthers undulate, reflexed, ciliate, ca. 1 mm. long, filaments glabrous, equaling galea, stigma small, capitate; capsule brown, ovate, 4-5 mm. long; seeds many, black with tight-fitting reticulate coat.

Distribution: common in the fields of San Francisco and vicinity. *Type locality*: probably near San Francisco. CALI-
FORKIA: Douglas (probably type collection, G); Pt. Reyes, Marin County, Eastwood in 1906, 4776 (CA); San Francisco, Jones 3269 (Po, CA), Heller 6595 (RM, Po, G, St, UC), Kellogg & Harford 698 (G, CA), Congdon in 1881 (St, UC), Rattan in 1878, in 1884, in 1886 (St); Colma, M.K.C. 68 (St); San Bruno Mountain, Ferris 2134 (St), Eastwood in 1919 (CA); South San Francisco, Elmer 4522 (Po, CA, St), Baker 346 (Po, G, UC, WS, CA, RM); Lake San Andreas, Abrams 2321 (Po, St, G), Baker 1926 (Po, UC, RM); Millbrae, Davy 1028 (UC); Burlingame, Eastwood in 1915 (CA); Belmont, Dudley in 1897 (St); Seal Cave, Dudley in 1900 (St).

Excluded or Doubtful Species


7. Orthocarpus pilosus var. monensis Jepson, Man. Calif., 940, 1925, is probably a variety under Castilleja pilosa Rydb., l. c. I have not studied any material of this variety.


A CONTRIBUTION TO OUR KNOWLEDGE OF THE NORTH AMERICAN CONOPIDÆ (DIPTERA)

BY

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In presenting the following tables and descriptions of species I wish to express my doubts as to the validity of several of the older species and to suggest the possibility that one or more of the new forms may later prove to be synonymous with previously described species.

In many cases there seem to be very few characters in the males by which they can be separated with any certainty. The genital plate on the venter of the abdomen of the female, which faces the large apical genital segment, seems to present reliable characters by which to separate the females. These characters have been used largely in the tables of Oncomyia and Zodion. The proportionate length of the antennal joints is also used in many cases. In the genus Zodion the markings of the thorax, the color of the pollen on the thorax and abdomen and the color of the front have been used, although as yet we cannot be sure of the limits of variation of these in the same species. The tables of Conops and Physocephala are based largely upon color characters. The former follows Kröber's table of North American species, but is changed so as to include the new forms and, in some cases, to correct what seems to be a misunderstanding of a described species.
species. The table of Zodion is based on that of Mr. Nathan Banks but there are many changes to include species not in his table, mostly forms described here.

Most of the species described as new are in the collection of the California Academy of Sciences, which it was my privilege to study during the winter of 1925-26.

In the list of species the name of the person placing a name as a synonym is included in parentheses. Where the form "(Aldrich Cat.)" is used the reader should refer to that work for the authority for the synonym.

1. **Conops foxi** Van Duzee, new species

Female: Length 7 mm. occiput, thorax, abdomen, coxae, femora, apical half of tibiae and all tarsi black; face yellow, facial grooves tinged with black; cheeks with a black spot, sometimes wanting; facial and posterior orbits with a narrow line of silvery, yellowish white pollen, which widens on upper part of face, extends narrowly on lower half of front, and does not reach the vertex on the posterior orbits; proboscis black, one and a half times as long as the head; antennae black, its joints as 1-2.5-1.5; a narrow line on side of the humeri, a triangular spot on sternopleuræ, sides and upper edge of metanotum, anterior surface of fore coxae and outer surface of fore and middle tibiae covered with silvery yellowish white pollen. Abdomen with tip of second and base of third segment yellow; narrow apical margins of third, fourth and fifth segments and posterior surface of sixth covered with yellowish white pollen. Bases and tips of femora, basal half of tibiae, halteres and pulvilli yellow; claws reddish, tips black. The brown wing stripe extends from the costa to third vein and darkens the two basal cells and the base of first posterior cell; a brown cloud in front of fifth vein fills more than half of discal cell as far as the anterior cross-vein; the posterior part of wing dark grayish, the brown shading into it.

*Type:* Female, No. 2397, Mus. Calif. Acad. Sci., taken by C. L. Fox, July 11, 1925, at Pullman, Washington. Two paratypes were taken at the same time as the type, and one paratype was taken at Metaline Falls, Washington, August 1, 1925, by Mr. Fox.

2. **Conops argentifacies** Van Duzee, new species

Female: Length 10 mm. Face, front and cheeks yellow, without spots or lines, except a slight blackish spot around ocelli and at base of antennæ, vertex reddish yellow, somewhat shining; facial grooves, a wide border on facial orbits, extending narrowly up the frontal orbits and
along the cheeks and forming a rather wide border on posterior orbits, but not reaching the vertex, silvery white pollinose. Antennae black, first joint red, the joints about as 1.5-3-2, style short, black, abruptly narrowed into a spine-like tip, which is shorter than the thick part, the projection at base oval, not as long as width of style; proboscis black, one and a fourth times as long as the head.

Thorax, abdomen, coxae and femora reddish; three confluent stripes on mesonotum, a spot on sternopleure, one above hind coxa, a spot in front of halteres and posterior surface of metanotum, black; mesonotum with white pollen; a small spot on inner side of humeri a spot on each side of metanotum and extending around the black of posterior surface, a faint stripe from middle coxae to root of wing, front of fore coxae and outer surface of fore and middle tibiae, silvery white pollinose. All hairs of thorax, abdomen and legs black; first abdominal segment blackish at base; third segment yellow on basal third, black above on apical two thirds, except a narrow hind border; fourth widely, fifth narrowly blackened at base above; ventral plate on fifth segment large and black; narrow apical margin of third segment, apical half of fourth, all but base of fifth and whole of sixth segment, white pollinose. Tibiae yellow on basal half, fore and middle ones darkened at tip, especially below; posterior ones with apical third black; tarsi wholly black; pulvilli and claws yellow, tips of claws black; halteres pale yellow.

Wings tinged with yellowish gray; the brown stripe fills the space between the first and third veins; there is a slight brown stripe in first posterior cell at base, along the spurious vein and in front of fifth and sixth veins; the petiole of first posterior and anal cells are of equal length.

A female, taken three days earlier at the same place, differs from that described only in having the petiole of first posterior cell shorter than that of anal cell, in having the pulvilli brown, second antennal joint reddish below, pollen of abdomen golden yellow and the ventral plate on fifth segment reddish. Am calling this Variety A.

Type: No. 2398, Mus. Calif. Acad. Sci., taken by C. L. Fox, July 18, 1925, at Lewiston, Idaho.

3. Conops fraterculus Van Duzee, new species

Male and female: Length 8.5-9 mm. Face, front and cheeks yellow, vertex and occiput more reddish yellow, shining; a wide stripe on facial orbits, extending narrowly up the frontal orbits and rather narrowly up the posterior orbits, but not reaching the vertex, silvery white pollinose; first and second antennal joints reddish, tip of second and third joint
black, antennal joints as 1-2.5-1.6; style short, blackish, tapering into a short yellowish bristle, projection at base small, rounded; proboscis black, one and a fourth times as long as the head.

Thorax reddish yellow; three confluent stripes on dorsum, a spot on sternopleurae, a small spot above hind coxae, a mark in front of halteres and posterior surface of metanotum, except upper edge, black; dorsum of thorax with white pollen; a small spot back of humeri, a spot in front of the base of the halteres, a margin surrounding the black of the metanotum and the sternopleurae, silvery white pollinose. Abdomen reddish; a spot on first segment, a large spot on posterior half of third segment which is divided by a reddish line, a spot on dorsum of fourth and a narrow mark on fifth, black; base of third segment yellow; narrow hind margins on third and fourth segments, apical half of fifth and whole of sixth covered with whitish pollen; ventral plate of female reddish; coxae, femora and tibiae yellow; tips of fore and middle tibiae blackened on one side, hind tibiae with apical fourth black; pulvilli and claws yellow, tips of claws black; all hairs and bristles on body and legs black.

Wings grayish; the usual brown stripe extends from first vein to third; a narrow brown streak in front of the spurious, fifth and sixth veins; petiole of first posterior cell a little shorter than that of anal cell; male with the dorsum of fourth and fifth abdominal segments largely black; third with a large black spot above. The ventral plate of female long, reddish, with a large, black, reticulated surface on posterior side at tip. One female has the pollen of the head and abdomen more golden yellow.

**Type:** Female, No. 2399, Mus. Calif. Acad. Sci., taken by C. L. Fox, July 17, 1925, at Lewiston, Idaho; Allotype, male, No. 2400, Mus. Calif. Acad. Sci., taken by J. G. Grundel, in Stanislaus Co., California, in August; and one paratype was taken at Lewiston, Idaho, July 21, 1925.

4. **Conops rubicundulus** Van Duzee, new species

Female: Length 10-13 mm. Face, front, checks and most of tibiae yellow; pollen on facial grooves silvery white, that on the orbits and tibiae pale golden yellow; antennæ black, lower part of first joint yellow and lower edge of second reddish, joints of antennæ as 1.3-3.5-2; style short, tapering to a bristle-like point, projection at base small, rounded at tip; proboscis black, a little longer than the head. Thorax, abdomen, coxae, femora and anterior surface of middle tibiae at tip, reddish; three confluent stripes on mesonotum, a spot on sternopleurae, a spot above hind coxae, a curved line in front of halteres, posterior surface of metanotum, except upper edge, a large spot on posterior surface of fore and middle tibiae, apical third of hind tibiae, all tarsi and base of first abdominal segment, black (in one specimen there are two black spots on the dorsum of third segment); dorsum of thorax white pollinose; a spot inside of
humeri, the sternopleuræ, a spot in front of halteres a border around the black of the metanotum, outer surface of all coxae and the first abdominal segment, silvery white pollinose; narrow apical margin of third abdominal segment, apical half of fourth, fifth except a narrow base and whole of sixth segment covered with pale golden yellow pollen; ventral plate reddish, of moderate size; pulvilli and claws yellow, tips of claws black; halteres pale yellow.

Wings grayish; the brown stripe extends from the first vein to third vein, it is produced forward more or less beyond the tip of the auxiliary vein and backward into the base of first posterior cell, leaving the cell in front of anterior cross-vein clear; a brown cloud in front of fifth vein and one in front of sixth vein, which shades the basal half of last posterior cell a little. Described from three females.

**Type:** Female, No. 2401, Mus. Calif. Acad. Sci., taken by C. L. Fox, July 16, 1925, at **Lewiston, Idaho.** Two paratypes were taken at the same location on July 15-17, 1925.

**Table of the North American Species of Conops**

1. Front wholly black or brown........................................ 2
   — Front wholly or partly yellow or yellowish brown.......... 11
2. Face wholly black; brown of wing reaching as far as third longitudinal vein; sixth and seventh veins clouded, (Mexico). 
   — Face wholly or partly yellow, sometimes more yellowish brown. 3
   — Large species, 18-25 mm.; deep black with blackish brown wing stripe........................................... *magnus* Williston
   — Smaller species.................................................. 4
3. Wings tinged with gray, with a quadrate brown spot; third antennal joint as long as first and second taken together, (Mexico)........................................... *parvus* Williston
   — Wings without such a spot, having the usual brown stripe...... 5
4. Wing stripe not very sharply defined.................................. 6
   — Wing stripe sharply limited..................................... 7
5. Wings almost wholly tinged with black; front metallic black; third antennal joint shorter than second, (North America) (following Kröber).......................... *brachyrhynchus* Macquart
   — Wing stripe reaching third vein and covering the two basal cells and base of first posterior cell; a brown cloud in front of fifth vein fills more than half of discal cell as far as anterior cross-vein; posterior part of wing dark grayish, the brown shading into it; antennal joints as 2-5-3, (Washington)...... ......................................................... *foxi* Van Duzee
6. Wings with a hyaline cross-band reaching from the costa to the cross-veins, tip of wing clouded........................................... 8
   — Wings with the usual brown stripe unbroken............... 9
8. Abdominal segments with pale posterior margins; wing stripe not reaching beyond fourth vein, except a narrow streak along fifth vein; second and third antennal joints of about equal length, (Eastern).....syl vosus Williston
   — Abdominal segments without pale bands; wing stripe reaching fifth vein; third antennal joint one and a half times as long as second, (Arizona).........arizonicus Banks
9. Wing stripe reaching third vein, behind which the wing is subhyaline, except a streak in front of fifth vein, (Mexico)....
   ...........................................discalis Williston
   — Wing stripe reaching beyond third vein.......................... 10
10. Third antennal joint about equal to second in length, (Eastern) ......................................................bulbirostris Loew
    — Third antennal joint two-thirds as long as second, (Mexico) ......................................................mexicanus Kröber
11. Front with a blackish cross-band and a median, vertical line which forks at the base of the antennae........... 12
    — Front without a distinct, forked median line, sometimes more or less uniformly infuscated.................. 15
12. Wing stripe in great part reddish yellow, (West Indies; Carolina)..................................................pictus Fabricius
    — Wing stripe brown or blackish, not reddish............... 13
13. Wing stripe reaching fourth vein, (Mexico)........soror Kröber
    — Wing stripe not reaching beyond third vein................ 14
14. Front with the median black stripe narrow and linear; female with front rather narrow, its pollen uniformly distributed, (Georgia; Texas)................striatifrons Kröber
    — Front with the median black stripe wide; front of female wide, its pollen in transverse lines, (Mexico)....pictifrons Kröber
15. Facial grooves with a brown spot or line.................. 16
    — Facial grooves wholly yellow................................ 17
16. Wings almost wholly tinged with brown, only the second basal cell hyaline, (Southern States)........femestratus Kröber
    — Posterior part of wing, including a large part of discal and first posterior cells subhyaline; a streak in first basal and anal cells pure hyaline, (Eastern States; Texas)...........
       ..................................................xanthopareus Williston
17. Second and third antennal joints of nearly equal length..... 18
    — Second antennal joint distinctly longer than third......... 20
18. Brown wing stripe nearly filling the space between fourth and fifth veins, (Mexico)........crescitus Wiedemann
    — Discal cell, except for a streak in front of fifth vein, nearly hyaline .................................................. 19
19. The vertical pollinose pleural stripe distinct, (Mexico)....
    ..................................................pallifrons Coquillett
    — Pleural stripe indistinct, (Arizona)....................... gracilis Williston
20. Third antennal joint scarcely longer than first, second twice as long as first, (South Carolina)..... pulchellus Kröber
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— First antennal joint only about one-third as long as second..... 23
23. Ventral plate of female long with a large black reticulated space on posterior surface; first posterior cell clear, except for a streak along the spurious vein, (Idaho)..................
..................fratereculus Van Duzee
— Ventral plate of female not very long, of moderate size; first posterior cell brown at base; discal cell brown beyond the anterior cross-vein, (Idaho)........rubicundulus Van Duzee

*Conops* brachyrhynchus variety semifuscus* Banks, would probably run to *discalis* Williston in the above table of species, but no doubt it is distinct. As Mr. Banks compares it with *brachyrhynchus* only and as I have never seen that species and have no very good description of it, I could not place it in the table.

5. *Physococephala brevirostris* Van Duzee, new species

Female: Length 8 mm.; of wing 6.5 mm. Face and lower half of front yellow; cheeks, occiput and vertex, upper half of front and a vertical line in the center of the front, connecting with a spot at root of antennae, red; center of the face silvery pollinose; orbits without a pollinose line; antennae red, basal joint more yellow, its joints as 6-17-18, style deep black, moderately long, straight above, tapering to a point from lower side, projection at base small; proboscis short, not much longer than the head, almost black, tip black.

Thorax and abdomen dark red; a wide median stripe on the mesonotum, extending over the front and reaching half way to the scutellum, a small spot in front of humeri, a spot at base of halteres and two spots, narrowly separated and rounded above, on posterior surface of metanotum, dull black; fore coxae and spots between the coxae shining black; posterior end of abdomen yellowish; no pollen is visible on the thorax and abdomen. Posterior coxae, femora, tibiae and tarsi red, fifth joint of all tarsi, pulvilli and claws dark brown; knobs of halteres yellow, stem brown.

Wings blackish from the costa to fifth vein, extending slightly into anal cell at base of wing; apical part of discal cell beyond the anterior cross-vein, except a broad brown stripe along fifth vein, a very narrow
space in front of part of last section of fourth vein, and the posterior margin of the wing grayish; second posterior cell all gray, except a small space back of the petiole at tip of first posterior cell; last section of fourth vein one and a half times as long as the preceding section; petiole of first posterior cell longer than last section of fifth vein.

Type: Female, No. 2402, Mus. Calif. Acad. Sci., taken by Dr. E. C. Van Dyke, June 20, 1924, at Meadow Valley, Plumas Co., California, at 6,000 feet elevation.

6. Physoccephala humeralis Van Duzee, new species

Female: Length 15 mm.; of wing 9 mm. Face, front, a large spot on cheeks, halteres and broad base of all tibiae, yellow; proboscis red, black at base and tip; vertex yellowish; occiput, a narrow transverse line below vertex, a median frontal line, forked at base of antennæ, lower part of cheeks and a broad band at upper part of cheeks connected along the oral margin with lower part, red; a very narrow line of glistening yellowish pollen on lower half of facial orbits and extending up more widely on the posterior orbits, reaching the upper corner of the eye. Antennæ and style red, projection at base of style black and large; antennal joints about as 14-40-18, (in one male the second joint is only 35, not 40).

Thorax and abdomen red; three narrowly separated stripes on the mesonotum, the middle one extending over the front and only reaching the middle posteriorly, a spot in front of the humeri, most of coxae, spot at base of halteres and posterior surface of metanotum, narrowly divided by a red line into two parts, black; more or less black on dorsum of third abdominal segment and usually on fourth and fifth segments. A rather indistinct triangular spot on sternopleuræ and a short line above, silvery white pollinose; large spots on the humeri and sometimes a small spot inside, basal and apical margins of second segment of abdomen. narrow posterior border of third, apical half of fourth and fifth and most of sixth segment covered with golden yellow pollen. Femora and apical half of tibiae red, tarsi more yellow with last joints brown; pubi-villi brownish; claws red with black tips. On the dorsum of the abdomen the fifth segment is about half as long as fourth; ventral projection on fifth segment large, reddish, black on margin.

Wings with the costal cell yellowish; brown stripe reaching from first to fifth vein, apical part of discal cell from the length of the posterior cross-vein in front of anterior cross-vein except narrowly along the fifth vein, grayish; a spot on first posterior cell and posterior part of wing also grayish; the outer part of marginal cell brownish gray; last section of fourth vein one-fourth longer than the preceding section. Described from three females.
Type: Female, No. 2403, Mus. Calif. Acad. Sci., taken by C. L. Fox, July 16, 1925, at Lewiston, Idaho. Paratypes taken at the same place and about the same time.

Two of the specimens have the pollinarium of Aesclepius attached to the fore tarsi, the black base of the pollinarium is clasped around the bristle-like empodium with the two large yellow parts which carry the pollen extending out beyond, looking like large black and yellow empodii.

7. Physocephala humeralis simulans Van Duzee, new subspecies

Male and female: Differs from the female described above in being 10-11 mm. long; wing 6.5-7 mm. long; the antennal joints are as 1-3-2; the mesonotum has three confluent or narrowly separated stripes; in the female the fifth abdominal segment is from one-third to one-half as long as fourth segment on the dorsum; in the male the fourth and fifth segments are of nearly equal length on the dorsum. Described from three females and seven males.

Type: Female, No. 2404, Mus. Calif. Acad. Sci., taken by E. P. Van Duzee, April 7, 1923, at Potholes, Imperial Co., California; allotype, male, No. 2405, Mus. Calif. Acad. Sci., taken by C. L. Fox, at Lewiston, Idaho, July 18; paratypes were taken as follows, by J. A. Kusche, July 6, 1921, in Shasta Co., Calif.; by E. P. Van Duzee, June 27, 1922, at Salt Lake City, Utah; by C. L. Fox, July 12, 1925, at Wawawai, Washington, and July 16, 1921, at Lewiston, Idaho.

8. Physocephala aurificies Van Duzee, new species

Male: Length 9 mm.; of wing 6 mm. Face, front and cheeks wholly yellow with the orbits narrowly yellowish silvery; occiput yellowish brown, the lower part more brown as far as the lower corner of the eye. Antennae yellow, becoming red at base of third joint; its joints as 6-17-8; style red, short, tapering to a point, projection at base rather large, black; proboscis red, black at tip, a little longer than the height of the head.

Thorax red with three, narrowly separated, black stripes, the middle one extending over the front of the thorax, all abbreviated posteriorly; spots in front of the humeri, between the coxae, at base of halteres and the posterior surface of the metanotum black; spots of white pollen on and behind the humeri, back of suture, inside of humeri extended faintly between the black dorsal stripes, on the sternopleurae and a large one in
front of halteres. Abdomen red, a little blackened on the sides of third segment and on the dorsum of fourth and fifth segments; posterior margin of third segment, almost the whole of fourth and entire fifth and sixth segments covered with bright yellowish pollen, venter without a projection.

Wings with posterior half and the costal cell almost hyaline; auxiliary vein yellow, the others brown; the usual brown stripe extends from first to fifth veins, but leaves the apical part of discal cell from a point before the anterior cross-vein equal to the length of the posterior cross-vein, except a narrow line in front of fifth vein, the first posterior cell from just before the posterior cross-vein, except extreme tip, and apical part of marginal cell from a little before the tip of second vein, except the tip of the cell and a narrow line in front of third vein, nearly hyaline; last section of fourth vein only a little longer than the preceding section. Described from one male.

Type: Male, No. 2406, Mus. Calif. Acad. Sci., taken by E. P. Van Duzee, August 20, 1919, at Stockton, California.

9. Physocephala buccalis Van Duzee, new species

Male: Length 7-9 mm.; of wing 5-7 mm. Face and front yellow, vertex yellowish red; occiput varying from yellowish red to brown; a transverse stripe on upper part of front, widest in the middle and reaching the eye margin, and a median line, forked at base of antennae, dark red or brownish; a transverse red band on upper part of cheeks not quite reaching the eye, but narrowly connecting with the red of the occiput along the oral margin; proboscis more than twice as long as the head, red, its tip and base black, upper edge darkened. Antennæ red, third joint more brownish and about half as long as second, first one-third as long as second; style short, abruptly pointed at tip, the upper edge nearly straight, the projection on the side rather large.

Thorax red, dorsum with three, narrowly separated, black stripes, the middle one extending over the front of the thorax and abbreviated posteriorly, lateral ones shortened anteriorly and posteriorly. A spot below the humeri, one at base of halteres, the sternopleuræ and posterior surface of metanotum black; usually there is a notch on the upper edge of the black on metanotum; humeri yellowish with yellow pollen on upper surface; metanotum with traces of white pollen on the sides. Abdomen black with more or less black on the dorsum of third and fourth segments; apical border of third segment, more or less of fourth and whole of fifth and sixth segments, covered with yellow pollen; ventral projection small, reddish.

Femora and apical half of tibiae red, basal half of tibiae and tarsi yellow, apical joints of tarsi brown; pulvilli and claws brown.

Wings grayish; costal cell yellowish; the usual brown stripe extends from the first vein to fifth; apical part of discal cell from before the
anterior cross-vein, except narrowly along fifth vein, an elongated spot in front of last section of fourth vein and one in apical part of marginal cell from just before the tip of first vein, grayish, sometimes these spots are not very distinct, the brown shading over them, but leaving them much lighter than the rest of the stripe; last section of fourth vein a little longer than the preceding section. Described from three males.

Type: Male, No. 2407, Mus. Calif. Acad. Sci., taken by E. P. Van Duzee, June 27, 1922, at Great Salt Lake, Utah. One paratype was taken at Pleyto, Monterey Co., California, May 22, 1920, the other paratype at Pullman, Washington, July 11, 1925, by C. L. Fox.

This comes near affinis Williston, but in that species the first antennal joint is half and third joint more than half as long as the second, while in this the first joint is about one-third and third not over half as long as second joint, there are some color variations also, but they are not of much importance.

Table of North American Species of Physcephala

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7. Second and third antennal joints of nearly equal length; cheeks
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   .......................................................... *affinis* Williston
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   as long as second, third half as long as second, (Eastern). .
   .......................................................... *furcillata* Williston
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   longer than second, (California) ....... *brevirostris* Van Duzee
—. First antennal joint scarcely one-third as long as second, third
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   co) .......................................................... *burgessi* Williston
10. Front and face wholly yellow, lower part of posterior orbits
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    (Western states; Mexico) .................. *affinis* Williston
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    as long as third, (Western) ............... *simulans* Van Duzee
—. First antennal joint about one-third as long as second and two-
    thirds as long as third, (Idaho) ...... *humeralis* Van Duzee

*Physocephala maxima* Giglio-Tos. I could not place; the
female is 17 mm. long; reddish; thorax with a median black
stripe; Abdomen with second segment on the sides and third on dorsum with black spots. Front and face yellow testaceous; wings blackish, posterior margin paler. Mexico.

10. Zodion cinereiventris Van Duzee, new species

Female: Length 3.5 mm. Face and cheeks yellowish white; width of cheeks more than half the eye height; front red, darker above, with an acute triangular space around the ocelli; a very narrow line of silvery white pollen along the orbits reaching up to the middle of the front and to lower fourth of posterior orbits; proboscis black, one and a fourth times as long as the head height; palpi very small, black with black hair; antennae red, apical half of third joint and the arista black; third joint a little longer than second; occiput black with a little gray pollen.

Thorax and abdomen black, covered with gray pollen; mesonotum with black lines and the beginning of two more between them on the front edge, also two indistinct spots on each lateral margin; front surface of humeri black, upper surface gray with pollen. Abdomen with indistinct blackish spots where the pollen is thinner; base of fifth and sixth segments very narrowly shining black; sixth and terminal segment red with apical half of latter shining black, sixth with two spots of gray pollen; ventral plate dark red with black border, moderately large, not very conspicuous; pollen of abdomen in transverse lines; hairs of occiput, thorax and abdomen long and black.

Femora and tibiae red, more or less of upper surface of femora and indistinct rings on the tibiae black; tarsi reddish at base, tips brown; legs covered with gray pollen and rather long black hair; claws black; pulvilli whitish.

Wings gray, veins black, yellowish brown at root of wing; petiole of anal cell fully one-third as long as the cell, not quite reaching the wing margin; first posterior cell open.

Male: About as in the female, except that the silvery margin on the orbits is broader and reaches up nearly to the upper corner of the eye on the front and to middle of eye on posterior orbits; the proboscis one and a half times as long as the head height; second abdominal segment yellow on the sides of posterior half or more; sixth segment blackish, apical one wholly pollinose and like the abdomen with the pollen in transverse lines, ventral surface of apical segment black; hairs on thorax and abdomen shorter.

Sometimes the apical abdominal segment is wholly black, in both sexes. Described from eight females and nine males.

Type: Female, No. 2408, and allotype, male, No. 2409, Mus. Calif. Acad. Sci., collected by E. P. Van Duzee, at Huntington Lake, Fresno Co., California, in July, the former on the 8th and the latter on the 22nd; twelve of the paratypes were taken
at the same place and within the same dates: one was taken at Pleyto, Monterey Co., Calif., May 23, 1920, and one at Preston, Idaho, July 17, 1922, by E. P. Van Duzee; also one taken by Dr. F. E. Blaisdell, at San Diego, June 29, 1891.

11. Zodion basalis Van Duzee, new species

Male: Length 7 mm. Face and cheeks pale yellow, their pollen silvery tinged with yellow, as is also the line on the facial orbits, which extends narrowly to upper third of frontal orbits and to the middle of posterior orbits; front reddish yellow, more black at vertex; cheeks two-thirds as wide as the height of the eye, with a few slender black hairs; proboscis black, as long as the head height; upper half of occiput shining black, lower half opaque with gray pollen. Antennæ reddish, upper edge of first two joints and apical half of third blackish, the joints nearly as 2-6-3; arista as long as first antennal joint, occiput and front with long, thorax and abdomen with abundant but shorter, black hair. Thorax and abdomen black; mesonotum dulled with brownish pollen, marked with two indistinct lines of grayish pollen, which are wider posteriorly, nearly coalescing and reaching the scutellum which is more shining and has two slender marginal bristles; humeri and an irregular spot below on the pleuræ whitish pollinose; abdomen uniformly grayish pollinose, the pollen thinner on the center and base of the dorsum, leaving a minute black dot at base of each hair; genitalia black.

Fore coxae yellowish, more brown at base, their hair black; middle and hind coxae black; femora, tibiae and basitarsi yellow, upper edge of femora, especially at tip, and more or less of the tips of the tibiae blackish; last four tarsal joints black; pulvilli yellowish; claws black, red at base.

Wings yellow at base, apical two-thirds grayish; costal cell, including the subcostal vein, base of radius as far as the fork, base of fourth and fifth veins for about the same distance, and base of all other veins, saturate yellow; last section of fourth vein to preceding section as 7 to 9; petiole of anal cell and posterior cross-vein of about equal length, the former not reaching the wing margin.

Type: Male, No. 2410, Mus. Calif. Acad. Sci., collected by C. L. Fox, July 27, 1925, on the Moscow Mountains, Idaho, at an elevation of 3000 feet.

12. Zodion bilineata Van Duzee, new species

Male: Length 6 mm. Face and cheeks pale yellow, without hair; front reddish yellow, more brown on upper part; ocellar triangle shining, elongated downward; facial orbits silvery white, extending narrowly to upper third of front and to upper corner of eye on posterior orbit; occi-
put black wholly gray pollinose; hairs on occiput, thorax, and abdomen black and moderately long; proboscis black, as long as head height; palpi small, black with a long and short hair at tip; first two antennal joints brown, third wholly reddish, the joints about as 1.3-2-5, third wider than tip of second; arista black; cheeks more than half as wide as height of eye.

Thorax and scutellum covered with grayish pollen, dorsum with two very distinct black lines, which do not reach the front or scutellum. Abdomen reddish, first segment black, first and basal half of second segment covered with gray pollen, which contrasts with whitish pollen on the rest of the abdomen; no distinct abdominal spots; scutellum with long black hairs on the base and apical margin.

Coxae black with gray pollen and black hair, anterior pair reddish at tip; femora and tibiae reddish, more or less blackened; anterior femora with rather long black hair on posterior surface; tarsi largely blackish; claws red, black at tip.

Wings grayish, yellow at base and along the front to tip of first vein; first posterior cell open; first two sections of fourth vein of equal length, third shorter and last section a little longer; petiole of anal cell about as long as the vein that closes the cell. Described from one male.

Type: Male, No. 2411, Mus. Calif. Acad. Sci., taken by Dr. E. C. Van Dyke, July 4, 1922, on Wallowa Mountains, Oregon.

13. Zodion hirtipes Van Duzee, new species

Female: Length 4.5 mm. Face dark yellow with the depressed central portion and a small spot on the cheeks below the eye black. Front reddish, more brown at vertex, with a shining triangular space around the ocelli; occiput black; sides of face, front and occiput with long black hair; antennae wholly black, third joint nearly as long as broad, a little longer than second joint.

Thorax, abdomen, legs, feet and claws black, slightly shining; pulvilli whitish. Halteres yellow; calypters white; humeri covered with gray pollen, which continues in a faint broken stripe to above the root of the wings. Mesonotum with two narrow, indistinct lines of brownish pollen. Apical segments of abdomen with gray pollen on the sides, which is not distinctly limited; hairs on the thorax, femora and tibiae long and black, those on posterior surface of fore femora nearly as long as the width of femora.

Wings grayish; veins black and strong; last section of fourth vein ending abruptly at half the distance from the posterior cross-vein to the wing margin; petiole at apex of anal cell half as long as the cell, reaching the wing margin.

Male: Antennae black at base, its style pale at tip; cheeks nearly as wide as the eye height; proboscis black, reddish at base. Thorax shining
black with coarse yellowish brown pollen, which leaves indistinct black stripes, the pollen not thick enough to hide the shining black ground color, except when viewed obliquely; humeri covered with gray pollen. Abdomen shining black with thick dark yellowish gray pollen concealing the ground color on the sides and on the whole of the apical segments. Male genitalia shining black, reddish at base, with long black hair.


**14. Zodion albifacies** Van Duzee, new species

Female: Length 3.1 mm. Face and cheeks white; facial grooves blackish at upper ends; front yellow, frontal orbits brown, the brown tapering off downward. Antennæ yellow, first joint and apical end of third brown; second and third joints of nearly equal length, third wider than second. Proboscis very slender, facial projection to which it is attached white at base, brown on more than apical half, the brown sharply defined; proboscis black, narrowly yellow at base; palpi minute, white, occiput cinereous with two narrow, slender, black lines.

Thorax and spot at tip of scutellum greenish cinereous; mesonotum with a pair of narrow median black stripes, these are a little wider posteriorly and extend back of the middle; also two lateral blackish spots on each side. Abdomen velvety black with whitish pollen, a large spot covering the side of third segment and extending on to second, a large spot on upper part of side, a median dorsal line on fourth, very narrow hind margin to the fourth, and the whole of the narrow fifth segment, covered with cinereous pollen; the sixth and genital segments yellow, tipped with black, shining, the sixth a little dulled; ventral plate short, black; hairs of the thorax short, black; abdomen nearly bare.

Coxæ mostly yellow; femora and tibiae blackish with cinereous pollen; knees and base of tibiae yellow; tarsi, brown; pulvilli and claws pale yellow, tips of claws black. Wings grayish; first posterior cell narrowly open; petiole of anal cell half as long as the cell and reaching the wing margin. Described from one female.

_Type:_ Female, No. 2414, Mus. Calif. Acad. Sci., collected by O. C. Poling, August 15, 1924, on the Baboquivari Mts., Arizona, and kindly presented to the Academy by Mr. C. L. Fox.
15. Zodion angusticornis Van Duzee, new species

Female: Length 3.7 mm. Occiput, thorax, abdomen and coxae shining black; face and cheeks pale yellow with silvery white pollen, depressed part of face brown; proboscis black, once and a half times the height of head; front reddish, vertex black; facial orbits, extending narrowly to upper third of front and to the middle of posterior orbits, silvery white pollinose; antennae nearly as long as the front, yellow, brown at tip, second and third joints of about equal length, third as wide as apex of second; arista blackish.

Dorsum of thorax with thin gray pollen, when viewed obliquely two rather wide, narrowly separated, stripes are visible; humeri, a spot behind, a stripe below the pleural suture, a triangular spot on sternopleurae, a small one above base of halteres and spots on all coxae silvery white pollinose; hairs on thorax, abdomen and legs brownish yellow; ventral plate long and thin, black, more brown in the center.

Femora and tibiae blackish, tinged with red, knees yellow, tarsi brown, first joint more yellow; pulvilli and basal half of claws white, apical half of claws black; halteres and calypters whitish.

Wings grayish; veins black, yellow at base of wing; first posterior cell open; last section of fourth vein straight; petiole of anal cell a little more than a third as long as the cell, nearly reaching the wing margin. Described from one female.

_Type:_ Female, No. 2415, Mus. Calif. Acad. Sci., taken by E. P. Van Duzee, May 22, 1918, at Los Banos, California.

_Table of the North American species of Zodion_

| 1. Scutellum nearly triangular, projecting; thorax and abdomen with small black spots, (Western) willistoni Banks |
| 2. Scutellum rounded; thorax, if marked, with lines not spots |
| 3. Thorax with whitish lines |
| 4. Thorax with brown lines or unmarked |
| 5. Abdomen mostly pale with oblique dark bands or spots, (Western) obliquefasciatum Macquart |
| 6. Abdomen largely black or blackish |
| 7. Abdomen with its pollen wholly deep golden yellow, (Texas) albonotatum Townsend |
| 8. Abdomen with whitish pollen on the anterior segments, golden yellow on last three, (Mexico) auricaudatum Williston |
| 9. Small species, not much over four millimeters long |
| 10. Larger species, six millimeters long or over |
| 11. First posterior cell closed |
| 12. First posterior cell open |
| 13. First posterior cell closed at the wing margin, at most its petiole not as long as the anterior cross-vein, (North America) abdominale Say |

June 11, 1927
— Petiole of first posterior cell longer than the anterior cross-vein ................................................................. 8
8. Second and third abdominal segments reddish, the others black, (Arizona) .................................................. scapularis Adams
— Abdomen wholly black; petiole of first posterior cell as long as the posterior cross-vein, (Arizona) ........... parvum Adams
9. Entirely black species, (California) ............ nigrifrons Kröber
— Front and face yellow, reddish or reddish brown ............ 10
10. Thorax black, without distinct stripes .................................................. 11
— Thorax black with distinct lines of gray pollen, or covered with gray pollen which leaves black lines ..................... 12
11. Fore femora with black hair which is nearly as long as the thickness of the femora; thorax with indistinct lines, (California). .......................................................... hirtipes Van Duzee
— Femora with the usual short hair; thorax shining black; humeri gray pollinose, (California) .......... angusticornis Van Duzee
12. Hairs of the fore femora as long as the width of the femora, (California) .......................................................... barkisetipes Van Duzee
— Hairs of fore femora short as usual ........................................ 13
13. Abdomen gray pollinose with very indistinct spots, (California; Idaho) ..................................................... cinereicentris Van Duzee
— Abdomen black, opaque, with gray pollinose markings ..... 14
14. Ventral plate of female very small, wholly black, (Arizona) .......................................................... albifacies Van Duzee
— Ventral plate of female large, reddish with a black edge .... 15
15. Pollen of thorax and abdomen tinged with green; first four abdominal segments opaque black, with narrow hind and wide lateral margins cinereous pollinose, (Eastern) ...................... nanellum Loew
— Pollen of thorax and abdomen brownish gray; abdomen with the black divided into two parts by a fine, median, pollinose line; hind margins, sides and bases of segments cinereous pollinose, (Western) .......................................................... pygmaeum Williston
16. Palpi long and clavate, (Illinois) .................... palpale Robertson
— Palpi very small, cylindrical .............................................. 17
17. First posterior cell closed .................................................. 18
— First posterior cell open .................................................. 19
18. Thorax gray with two or three, distinct, dark stripes; abdomen usually dark in color, (North America) ................................ fulvifrons Loew
— Thorax with the stripes not so distinctly marked; abdomen of male reddish yellow or reddish brown, (Eastern) .......................................................... abdominale Say
19. Thorax not distinctly striped .............................................. 20
— Thorax with distinct stripes .............................................. 22
20. Legs mostly dark; abdomen wholly blackish, (California) .......................................................... tristis Bigot
— Legs mostly pale in color .................................................. 21
21. A wholly shining black species with coarse yellowish pollen on the thorax and abdomen, (Idaho) .......basalis Van Duzee
— Abdomen partly or wholly pale; third antennal joint fully as long as second, (California) ............obscurum Banks
22. Proboscis beyond the palpi fully twice as long as the head height, (California; Oregon) ..................reclusum Banks
— Proboscis shorter ................................................................. 23
23. Thorax gray with two or three blackish lines or stripes besides the lateral spots......................................................... 24
— Thorax with four or five dark stripes besides the lateral spots, the intermediate ones distinct only in front........... 25
24. Second and third antennal joints of very nearly equal length, (North America) ..................fulvifrons Loew
— Third antennal joint more than twice as long as the second, the joints being as 13-20-50, (Oregon) .......bilineata Van Duzee
25. Female with the ventral plate fully twice as long as wide; the abdomen very slender and compressed; male with pale abdomen, (North America) ..................perlongum Coquillett
— Ventral plate of female much shorter in proportion to its width... 26
26. Ventral plate of female much shorter than wide, its striated area on posterior surface broad, (Virginia; Oregon; California). .........................................................sayi Banks
— Ventral plate of female as long as wide or longer.............. 27
27. Ventral plate of female one and a half times as long as wide, (Eastern) ..................intermedium Banks
— Width and length of the ventral plate of female equal, (Oregon) .............................................occidentale Banks

16. Dalmannia hirsuta Van Duzee, new species

Female: Length 7 mm. Face and cheeks wholly yellow; front blackish with black hair; antennae brown, second joint scarcely as long as third; occiput black with white hair, a few black ones back of proboscis; palpi black with black hair.

Thorax shining black; dorsum covered with long black hair, that on the yellow humeri yellowish; scutellum yellow, black at base, covered with long black hair. Abdomen black; first segment reddish at base, second with the posterior third yellow, this yellow portion with a long projection extending forward near each side and three very small ones between; third, fourth and fifth segments with the yellow hind margin very narrow at the sides, wide in the middle and with three projections on the wide part, the middle one nearly reaching the base on fourth and fifth; sixth segment with three yellow stripes which meet at apex of segment; pile on abdomen rather long, black, except on the sides and middle portion of second segment.

Fore coxae, femora and tibiae yellow, upper surface of anterior and posterior femora black; tarsi black; pulvilli and claws white, tips of
claws black. Halteres yellow; wings brownish with brown veins. Described from one female.

_Type:_ Female, No. 2416, Mus. Calif. Acad. Sci., taken by E. C. Van Dyke, June 11, 1925, at Corvallis, Oregon.

**Table of North American species of Dalmannia**

1. Scutellum wholly black; humeri black. (California) .................. nigriceps Loew
   —. Humeri yellow; scutellum partly yellow .............................. 2
2. First abdominal segment black, yellow at base and on apical margin; second to fourth yellow with black spots, which are sometimes slightly connected, (Oregon) ............... pacifica Banks
   —. Abdomen black; segments two to four with yellow hind margins, which are emarginate or have extensions of the yellow in front .................................................. 3
3. Pile of thorax whitish .......................................................... 4
   —. Pile of the thorax black, at least in the middle .................... 5
4. Yellow of abdominal bands not produced forward on the sides, but that of third and fourth segments extending forward in the middle, (Eastern) .................. nigriceps Loew
   —. Yellow of abdominal bands extending forward on both sides and middle of segments two to four. (New Mexico; California). .............................................. picta Williston
5. Pile of the thorax short, black in the center, yellowish on the front of the dorsum and on the scutellum; that of the abdomen largely black, rather short, (California) .................. blaisdelli Cresson
   —. Pile of the thorax and scutellum long and black, except on the humeri; that of the abdomen rather long, black, except on the sides and center of second segment, (Oregon) ............... kirsuta Van Duzee

17. **Oncomyia infuscipes** Van Duzee, new species

Female: Length 7.7 mm. Black with the following parts yellow, front, except the vertex and two lines running downward from the vertex and meeting on the middle of the front, face, cheeks, lower edge of first antennal joint, inner surface and lower part of second and third antennal joints, most of the fore coxae, lower half of fore and middle femora, except near the tip, basal two-thirds of hind femora, about basal third of all tibiae, most of basal joint of all tarsi, pulvilli, claws, except at tip and the halteres; front with rather long black hair down to the antennae; cheeks with conspicuous, but sparse black hair all over; joints of antennae as 15-32-25; apical section of proboscis distinctly longer than first; cheeks and anterior surface of fore coxae covered with silvery pollen; dorsum of thorax quite thickly covered with brownish pollen, that on the humeri paler, anterior surface of thorax shining; lower half of occiput
opaque with white pollen; abdomen with quite thick whitish pollen; genital segment shining black; hairs of thorax and abdomen wholly black, but those on apical part of abdomen more brown in certain lights; ventral plate of female broad, semicircular, shining black. Wings tinged with brown; costal cell and veins at base of wings yellow.

Male: Antennal joints about the same as in the female; second section of proboscis a little longer and a little yellow at tip; abdomen thickly covered with dark grayish pollen, especially towards the posterior end and including the genital segment; vertex black, below that the front is brown with a large yellow spot in the center above the antennæ, which does not reach the orbits.

Type: Female, taken by the author at Kearney, Ontario, August 1, 1911, in his collection. Allotype, male, No. 2417, Mus. Calif. Acad. Sci., taken by author at Irving, Erie Co., N. Y. One paratype taken with the allotype.

18. Oncomyia brevirostris Van Duzee, new species

Female: Length 5 mm. Black, the following parts yellow: lower half of front, extending a little up the orbits, face, cheeks, antennæ, except the upper edge, most of fore coxae, base of fore and middle femora, basal half of hind femora, narrow base of all tibiae, most of basal joint of all tarsi, pulvilli, base of claws, and the halteres; apical part of proboscis a little yellowish; facial grooves blackened on upper half. Cheeks with two or three hairs besides those near the edge; last section of proboscis about three-fourths as long as first; joints of antennæ as 13-24-16; anterior surface of fore coxae and fore and middle tibiae covered with silvery pollen; upper surface of thorax dulled with a little grayish pollen; humeri, lower half of occiput and apical half of second abdominal segment on the sides covered with white pollen; genital segment of abdomen shining black; ventral plate semicircular, shining black; wings rather dark grayish; costal cell and base of wings yellow.


19. Oncomyia propinqua Adams

There seems to be no reason to separate propinqua Adams from loraria Loew, the description fitting the male of that species very well. The males are very difficult to separate, but for the present we will be quite safe in considering it that species.
20. **Oncomyia æqualis** Van Duzee, new species

Length 5.5-6 mm. Black, the following parts yellow: less than lower half of front, extending somewhat up the orbits, face, cheeks, inner surface and lower edge of antennæ, most of fore coxae, narrow base of fore and middle femora, basal half of hind femora, base of all tibiae, most of basal joint of all tarsi, pulvilli, claws, except their tips and the halteres. Cheeks with a very few hairs on their surface, besides those on the edge; proboscis with the second section only a little shorter than the first; joints of antennæ as 13-25-22; thorax dulled with a little gray pollen; lower half of occiput, humeri and a considerable part of second abdominal segment covered with thick white pollen, there is a little thin white pollen on the remainder of the abdomen, which is visible in certain lights; genital segment shining black; ventral plate semicircular, shining black; wings grayish, a little yellow at root.

**Type:** Female, No. 2419, Mus. Calif. Acad. Sci., taken by the author, May 11, 1926, at Lower Lake, Lake Co., California. One paratype taken by the author May 15, 1915, in Muir Woods, Marin Co., California, is in the author's collection.

21. **Oncomyia terminalis** Van Duzee, new species

Female: Length 4-4.2 mm. Black with base of femora and tibiae, halteres, base of wings, more or less of the antennæ and sometimes lower half of the front, yellow; sometimes the front is wholly brown; face and cheeks yellowish white; third antennal joint a little shorter than second; hairs on the lower edge of the cheeks black; proboscis black, more or less reddish at tip, its segments of about equal length; palpi black, moderately long, a little clavate; front wholly covered with long black hair. Thorax and abdomen shining black with black hair. Ventral plate narrow, short, about as long as wide, shining black. Fore coxae largely yellow with black hair and several long, curved, bristly hairs at tip. Pulvilli and base of claws yellowish white, tips of claws black. Calypters and their cilia pale yellow. Wings grayish; veins black, yellow at root of wing.

**Type:** Female, No. 2420, Mus. Calif. Acad Sci., taken by E. C. Van Dyke, June 14, 1920, at Hood River, Oregon. Three paratypes, all females, were taken in Washington, by C. L. Fox, in 1925, in the following places: Pullman, July 11: Colfax, July 10, and Metaline Falls, August 1.
22. *Oncomyia angusticornis* Van Duzee, new species

Male and female: Length 3.5-4 mm. Shining black; front, face, cheeks, narrow base of tibiae and knobs of halteres yellow. Front nearly bare; cheeks with silvery white pollen, which extends a little way up on the posterior orbits and very narrowly up the frontal orbits to the vertex; lower half of occiput opaque with white pollen, upper half shining. Antennae blackish, or more or less reddish; second joint longer than third, third slightly narrower than usual and almost reaching the oral margin; style very short, placed near the middle of third joint; hairs on the oral margin of the cheeks short and delicate; proboscis and the small palpi black, the former with its segments of nearly equal length. Most of the hairs on thorax, abdomen and legs pale, yellowish or grayish, but sometimes they appear blackish, or even quite black, those on the lower surface of femora long; pulvilli and base of claws yellow, tips of claws black. Pollen on thorax and abdomen in female very thin, more conspicuous on the abdomen of the male but never very abundant. Femora a little thickened. Ventral plate of female quite long and moderately narrow, shining red, shading into a black border. Wings grayish, yellow at base; first vein wholly yellow, veins on apical part of wing black. Calypters and their cilia white. Described from seventeen females and seven males.

*Type:* Female, No. 2421, and *allotype,* male, No. 2422, Mus. Calif. Acad. Sci., taken by C. L. Fox, July 27, 1925, on *Moscow Mountain, Idaho,* at 3000 feet elevation.

The paratypes were taken at the following places: four females, Atascadero, Monterey Co., Calif., April 26, 1919, E. P. Van Duzee; one female, Paradise Valley, Kings River, Fresno Co., Calif., July 19, 1910, E. C. Van Dyke, at 7000 feet; one male and four females, Huntington Lake, Fresno Co., Calif., July 9-28, 1919, E. P. Van Duzee, at 7000 feet; one male, Lewiston, Idaho, July 21, 1925, C. L. Fox; one male and two females, same data as type; one female, San Pedro, Calif., October 25, 1909, E. C. Van Dyke; one male, Shasta Co., Calif., July 11, 1921, J. A. Kusche; one female, Colton, Calif., May 26, 1917, E. P. Van Duzee; one female, Corona, Calif., September, 1920, G. R. Wilson; one male, Forks, Clallam Co., Wash., July 1, 1920, Helen Van Duzee; one female, Warner Mts., Lake Co., Oregon, June 19, 1922, E. C. Van Dyke; and one female, Cochise Co., Arizona, June 26, 1916, Virgil Owen.
23. **Oncomyia nigra** Van Duzee, new species

Male and female: Length 6 mm. Shining black, except the following parts which are yellow: lower half of front and narrow orbits, face, cheeks, lower half of antenna, halteres, calypters, wide base of hind femora, narrow base of four anterior femora, base of all tibiae and tarsal claws, pulvilli and base of wings. The shining space around ocelli extends downward in an acute point. Front, occiput, thorax and abdomen with quite long black hair; cheeks with a few black hairs on their surface and a row of black hairs on their oral margin which are about as long as the first antennal joint; cheeks with silvery white pollen, which extends narrowly up to the middle of the eye on both frontal and posterior orbits. First antennal joint less than half as long as third, which is three-fourths as long as second joint. Palpi small, black; proboscis with apical segment in female about as long as the first, in the male a little shorter. Femora much thickened. Ventral plate of female narrow and rather long, shining black. Apical half or more of wing faintly tinged with brown, contrasting with the yellow base.

**Type:** Female, No. 2423, and allotype, male, No. 2424, Mus. Calif. Acad. Sci., collected by E. P. Van Duzee, June 11, 1925, at Corvallis, Oregon. One paratype, same data.

**Table of North American Species of Oncomyia**

1. Ventral plate of female narrow, its sides nearly parallel for half their length ............................................. 2
— Ventral plate wide, rounded from the base......................... 5
2. Ventral plate of female long, dark reddish or brownish with a distinct black border; more or less of the hair on apical part of abdomen distinctly pale in color, (Western).............
— Ventral plate wholly shining black, if tinged with red then uniform in color, without a distinct black border........... 3
3. Ventral plate of female long; hairs on the edge of the cheeks short, (Oregon).................................. nigra Van Duzee
— Ventral plate of female short, as long as wide................. 4
4. Ventral plate tinged with red; hairs on abdomen, especially on apical segments and sides largely pale, often tinged with yellow, (Eastern).................................... loraria Loew
— Ventral plate wholly deep shining black; hairs on abdomen almost wholly black, (Oregon; Washington)....................
— terminalis Van Duzee
5. Femora and tibiae mostly reddish, sometimes brownish above or at tip ....................................................... 6
— Femora and tibiae nearly half or more than half black........ 7
6. Third antennal joint about one-fifth shorter than second, the joints being as 10-26-20; hair on apical part of abdomen usually largely pale, (Eastern).............. abbreviata Loew
—. Third antennal joint more than one-fourth shorter than second; hair of abdomen wholly or almost wholly black, (Western).

7. Ventral plate of female very short, wide, shining black; hairs on abdomen usually largely pale. (Western) ...modesta Williston

8. Ventral plate of female almost a true semicircle

8. Abdomen of female mostly covered with pollen; joints of antennae as 15-32-25; second section of proboscis longer than first, (Ontario) ...infuscipes Van Duzee

—. Abdomen almost without pollen, except on second segment; second section of proboscis not longer than first.

9. Third antennal joint only slightly shorter than second, the antennal joints being as 13-25-22; second section of proboscis a little shorter than first, (California) ...willistoni Van Duzee

—. Third antennal joint one-fourth shorter than second, the joints being 13-24-16; second section of proboscis about three-fourths as long as first, (California) ...brevirostris Van Duzee

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**Table of the North American Species of Myopa**

1. Wings marked with brown or the cross-veins clouded......... 2

—. Wings unspotted, but sometimes uniformly infuscated....... 8

2. First posterior cell closed before the wing margin........ 3

—. First posterior cell open........................................ 5

3. Wings strongly infuscated, especially across the middle, base light yellow; hairs of abdomen white, (Eastern)...........vesiculosa Say

—. Cross-veins clouded; a conspicuous spot in first posterior cell, (Washington; California)..................melanderi Banks

—. Cross-veins unclouded; no spot in first posterior cell; stigma brown ........................................... 4

4. Wings tinged with reddish, (Nevada)..................castanea Bigot

—. Wings tinged with yellow; first marginal cell brown, second marginal cell scarcely tinged with yellow, (Colorado)...........flavopilosa Kröber

5. Wings with a brown spot in first and second posterior cells, (Arizona; California)..................willistoni Banks

—. Wings otherwise marked with brown; no spots in the posterior cells ........................................... 6


—. Wings broadly yellow at base, brown apically, with a more or less broken, hyaline cross-band or streaks.................. 7

7. A hyaline streak in first posterior cell and also in discal cell; nearly the whole of second posterior cell hyaline; a brown cloud back of fifth vein, (Mexico) ..........fenestrata Coquillett
—. The hyaline cross-band reduced to a subtriangular spot next to fourth vein; wings hyaline back of fifth vein, (Mexico)

8. Thorax and abdomen with white or yellow hair

9. Hair of thorax and abdomen black

9. Hair of thorax and abdomen white

10. Hair of thorax and abdomen yellowish

10. Wings with a dark shade across the middle (United States), (perhaps conjuncta Thom.)

9. Wings without a dark shade; abdomen wholly reddish, (Nebraska)

11. Abdomen red with two black lines on third segment, its hair yellow, (North America)

11. Abdomen red without black marks, except narrow cross-bands; hair bright yellowish brown, (Colorado)

12. Antennæ very short, second and third joints of nearly equal length, each about as long as wide, (California; Colorado), (perhaps this should go in Sicus)

12. Antennæ as long as the head, (Eastern)

12. Antennæ of moderate length, second and third joints distinctly longer than wide

13. Knobs of halteres brown, (no locality given, probably from Kansas)

13. Knobs of halteres yellow or whitish

14. Abdomen mostly blackish, at least on the dorsum

15. Abdomen wholly reddish, or nearly so

15. Abdomen reddish on the sides and at tip

15. Abdomen almost wholly black, its hair rather short, (Eastern)

16. Hair on abdomen long, (Washington)

17. Hair on the abdomen short, (Arizona)

17. Abdomen with very short and scattering hair, wholly shining, (Western)

18. Abdomen with the hair as long as usual; always more or less pollinose

18. Proboscis very short; second and third segments taken together not much longer than fore femora, (Western)

19. Proboscis very long, its segments each as long as fore femora

19. Abdomen red with an oval white pollinose spot on each side at the posterior margin of second, third and fourth segments; wings moderately infuscated; first posterior cell closed and petiolate, (Eastern)

19. Abdomen more or less black on the dorsum; humeri black; first posterior cell open; wings wholly hyaline with the base yellow, (British Columbia; Maine; Washington; Nevada)

—. clausa aperta Roder
North American species of *Sicus*

— Mouth parts black; face and cheeks pale yellow; antennae reddish yellow; abdomen black, second and third segments in male largely yellow in ground color; legs black, knees yellow; wings hyaline, tinged with gray at base and in costal cell; first posterior cell closed and petiolate; halteres yellow; length 4 mm., (Mexico).......... *brevirostris* Coquillett

— Face and cheeks pale yellow; palpi yellow; antennae black with second joint reddish yellow; abdomen shining black; legs and feet almost wholly reddish yellow; wings grayish, veins black, narrowly clouded with brown; first posterior cell open; length 5.7 mm.; halteres and calypers yellow, (Alaska)....

.......................... *ciliatus* Van Duzee

24. *Sicus ciliatus* Van Duzee, new species

Male: Length 5.7 mm. Head black; lower third of front yellow; face, cheeks and palpi pale yellow; cheeks on oral margin with long, converging, whitish hair, these hairs as long as the antennae; occiput opaque with gray pollen, its hair short and brownish on upper part, very long and white below, sides with a few black hairs. Antennae very short, with first and third joints black, second reddish yellow, third a little longer than wide, as long as two basal joints taken together; style about as long as width of third antennal joint, inserted at its base; palpi longer than the antennae, elongate oval with a short petiole, fringed with long white hair; proboscis shining black, as long as the height of the head, its second segment apparently only about as long as wide (it may be broken).

Thorax, abdomen and all coxae shining black; three wide stripes on mesonotum, the lateral ones divergent, and most of the pleuræ opaque with coarse, gray pollen which is tinged with yellow in places; bristles of thorax yellow except one black one in front of each wing; four bristles on each side of front, one each side of scutellum near the middle, two on upper posterior edge of pteropleura, yellow; these last two bristles are continued downward by a row of stiff hairs; hairs of the abdomen, coxae, sternopleura, femora and tibiae yellowish white and long; most of the hairs on the tarsi and the bristles of the legs black. Abdomen with only a little gray pollen on the dorsum. A pair of small hypopygial appendages and the ventral plate black, a long, two-jointed filament extends downward from behind the ventral plate. Femora considerably thickened, yellowish red. Halteres and calypers yellow, the latter with white cilia.

Wings grayish, costa brown; veins black, a little clouded with brown which tinges the cells more or less; anterior cross-vein near apical third of discal cell; second basal and anal cells of nearly equal length; the vein closing the second basal cell imperfect; first basal cell extending considerably beyond the tip of first vein; last section of fifth vein short; vein closing anal cell perpendicular to sixth vein, which has its last section considerably longer than the first.

List of the North American Species of Conopidae

Genus Conops Linnaeus

anthreas Williston, Biologia, Diptera, iii, 80, 1892.
argentinacies Van Duzee, new species.
brachyrhynchus Macquart, Diptera Exotica, ii, 3, 15, 1843.
bulbiostris Loew, Neue Beitr., i, 30, 1853.
discalis Williston, Biologia, Diptera, iii, 80, 1892.
excisus Wiedemann, Auss. Zweifl. Ins., ii, 334, 1830. = sugens Wied. (Kröber.)
flaviceps Macquart, Diptera Exotica, ii, 3, 15, 1843.
foxi Van Duzee, new species.
fraterculus Van Duzee, new species.
fulvipennis Macquart, Diptera Exotica, ii, 3, 13, 1843.
magnus Williston, Kans. Univ. Quart., i, 43, 1892.
obscuripennis Williston, Trans. Conn. Acad., iv, 328, 1883. = brachyrhynchus Macq. (Aldrich Cat.)
ocellatus Giglio-Tos, Boll. R. Univ. Torino, vii, 132, 1892. = parvus Will. (Aldrich Cat.)
(pronto, Archiv. Naturg., 81, A, 5, p. 141, 1915.)
parvus Williston, Kans. Univ. Quart., i, 46, 1892.
pictus Fabricius, Ent. Syst., iv, 391, 1794.
quadrimaculatus Ashmead, Orange Insects, p. 69, 1880.
rubicundulus Van Duzee, new species.

sequax Williston, Biologia, Diptera, iii, 80, 1890.


sugens Wiedemann, Auss. Zweifl. Ins., ii, 236, 1830.


Genus *Physcephala* Schiner


aurifacies Van Duzee, new species.

brevirostris Van Duzee, new species.


buccalis Van Duzee, new species.

carbonaria Bigot, Ann. Soc. Ent. Fr., 1887, 42.

castanoptera Loew, Neue Beitr., i, 33, 1853.


humeralis Van Duzee, new species.


maxima Giglio-Tos, Boll. R. Univ. Torino, vii, No. 132, 1892.


simulans Van Duzee, new variety of *humeralis* Van Duzee.

sororcula Williston, Biologia, Diptera, iii, 83, 1892.


xanthopus Williston, Biologia, Diptera, iii, 83, 1892.

Genus *Zodion* Latreille


albifacies Van Duzee, new species.
albonotatum Townsend, Jl. N. Y. Ent. Soc., v, 175, 1897.
angusticornis Van Duzee, new species.
auricaudatum Williston, Biologia, Diptera, iii, 85, 1892.
basalis Van Duzee, new species.
bilineata Van Duzee, new species.
cinereiventris Van Duzee, new species.
flavipenne Bigot, Ann. Soc. Ent. Fr., 1887, 204. = fulvifrons
Say (Aldrich Cat.)
hirtipes Van Duzee, new species.
leucostoma Williston, Trans. Conn. Acad., vi, 380, 1885. = obliquefasciatum Macq. (Aldrich Cat.)
nanellum Loew, Cent. viii, 75, 1869.
obligeufasciatum Macquart, Diptera Exotica, Suppl., i, 141, 1845.
palpale Robertson, Can. Ent., xxxiii, 284, 1901.
perlongum Coquillett, Can. Ent., xxxiv, 199, 1902.
pymaeum Williston, Trans. Conn. Acad., vi, 381, 1885.
rufifrons Macquart, = fulvifrons Say (Banks).
splendens Jaennicke, Neue Exot. Diptera, 405, 1867. = oblique-
fasciatum Macq. (Aldrich Cat.)
zebrinum Bigot, Ann. Soc. Ent. Fr., 1887, 204.
Genus Stylogaster Macquart

biannulata Say, Jl. Acad. Nat. Sci. Phila., iii, 81, 1823; Compl. Writ., ii, 72. = stylata Fabr. (Wiedemann.)
stylata Fabricius, Syst. Antil., 177, 1805.

Genus Dalmannia Robineau-Desvoidy

hirsuta Van Duzee, new species.
nigriceps Loew, Cent. vii, 71, 1866.
vitiosa Coquillett, Ent. News, iii, 150, 1892.

Genus Oncomyia Robineau-Desvoidy

abbreviata Loew, Cent. vii, 73, 1866.
aequalis Van Duzee, new species.
angusticornis Van Duzee, new species.
baroni Williston, Trans. Conn. Acad., vi, 97, 1883.
brevirostris Van Duzee, new species.
infuscipes Van Duzee, new species.
loraria Loew, Cent. vii; 74, 1866.
melanopoda Williston, Trans. Conn. Acad., vi, 91, 1883. = var. of modesta Will. (Aldrich Cat.)
nigra Van Duzee, new species.
terminalis Van Duzee, new species.

Genus Myopa Fabricius

bistria Walker, List, iii, 679, 1849.
clausa Loew, Cent. vii, 72, 1866.
conjuncta Thomson, Eugenes Resa, Dipt., 515, 1868.—vesiculosa Say?
fenestrata Coquillett, Can. Ent., xxxiv, 197, 1902.
vicaria Walker, List, iii, 679, 1849.

Genus Sicus Scopoli

ciliatus Van Duzee, new species.
XIX

PALEONTOLOGY OF THE MIocene OF LOWER CALIFORNIA

by

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September 2, 1927
Introduction

This paper is a report on the available collections of fossils from the Miocene beds of Lower California, of which no extensive list has heretofore been published, and the fauna herein described extends our knowledge of the Miocene of western North America southward.

The greater part of the material upon which the report is based was collected by geologists of the Marland Oil Company chiefly in the regions of La Purisima and San Ignacio Lower California. Most of the material was deposited at Leland Stanford Junior University by Mr. Carl H. Beal, Chief Geologist of the company, through whose courtesy and that of Dr. J. P. Smith of the University, it has been available for the present study. A few specimens in the University collection were obtained by Mr. E. Call Brown in Lower California, and these have also been available for study. Pertinent collections of the California Academy of Sciences have also been considered.

A few species have heretofore been described or listed from the Miocene of Lower California. Gabb\(^1\) referred to *Ostrea titan* Conrad in 1868 and 1869\(^2\). A few species have been listed by Dickerson\(^3\), Arnold and Clark\(^4\), Darton\(^5\), and Heim\(^6\). Kew\(^7\) described one species thought to be of Miocene age from Lower California. Hertlein\(^8\) in 1925 described or listed the pectens in the collections made by the geologists of the Marland Oil Company. The geologic occurrence of the Miocene beds at various places in Lower California has been discussed by Wittich\(^9\), Heim\(^10\), geologists of the Marland Oil Company\(^11\), and Jordan and Hertlein\(^12\).

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\(^2\) Resources of the Pacific Slope, 1869, pp. 114, 633.


\(^5\) Jour. Geol., Vol. 29, No. 8, 1921, pp. 731-741.

\(^6\) Geol. Mag., Vol. 59, No. 702, 1922, p. 536.


\(^10\) Zeit. für Vulcanologie herausgegeben von Imm. Friedlander, Bd. 6, 1921, pl. 4; Geol. Mag., Vol. 59, No. 702, 1922, pp. 536-541.


In the present paper a general list of the Miocene fossils is given, followed by each separate locality with its respective faunal list. The relations of the present fauna to Miocene faunas elsewhere are considered. Notes on certain species are given and sixteen new species are described.

The writers wish to acknowledge the help received from Dr. G. Dallas Hanna, Curator of Paleontology in the California Academy of Sciences, for advise and assistance in various ways during the preparation of the manuscript; Mr. Carl H. Beal of the Marland Oil Company of California, for permission to publish upon collections made by geologists of that company. They also wish to thank Dr. J. P. Smith of Leland Stanford Junior University for permission to study these collections and for helpful suggestions and criticism during the study; Mrs. I. S. Oldroyd for permission to study specimens in the Conchological Museum of Leland Stanford Junior University, and Dr. B. L. Clark for permission to examine type specimens in the University of California. The greater part of this material is now in the Paleontological collections of the Leland Stanford Junior University; paratypes where available and plastotypes are in the collections of the California Academy of Sciences.

**List of Miocene Species**

**Echinoidea**


**Pelecypoda**


**Gastropoda**

33. *Forreria sp.*, Loc. 60 (L.S.J.U.).
42. *Turritella ocoyana* Conrad, Loc. 60; 66 (L.S.J.U.).
Cirripedia

46. *Balanus* sp., Loc. 68 (L.S.J.U.).
47. *Balanus* sp., Loc. 58 (L.S.J.U.).

Sharks Teeth


Localities and Faunal Lists

Loc. 57 (L.S.J.U.). La Purisima cliffs, San Ramon River, Lower California; E. Call Brown collector.

*Ostrea* sp.
*Pecten* (*Lyropecten*) *crassicardo* Conrad.
*Pecten* (*Lyropecten*) *pretiosus* Hertlein.
*Calyptrea costellata* Conrad.
*Turritella* sp.

The fossils from this locality show excellent preservation. They occur in the fine grained white sandstone of the Isidro (?) formation which is lower Miocene in age.


*Area* sp.
*Cardium* sp.
*Glycymeris* sp.
*Scutella* sp. (fragments).
*Balanus* sp.

The casts of the mollusks listed and the lithology indicate lower Miocene age.

Loc. 59 (L.S.J.U.). Turritella bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower Cali-
California, on the trail from Arroyo Mesquital to La Purisima, Lower California. E. Call Brown collector.

_Ostrea_ sp.  
_Ostrea_ sp.  
_Pecten (Lyropecten) pretiosus_ Hertlein.  
_Turritella ocyana_ Conrad.  
_Turritella wittichi_ Hertlein & E. K. Jordan, new species.

This assemblage indicates Temblor, lower Miocene age. The lithology is apparently the same as that of the Isidro formation.

Loc. 60 (L.S.J.U.). West side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California; lower Miocene; B. F. Hake collector.

_Chione_ aff. _temblorensis_ Anderson.  
_Forneria_ sp.  
_Turritella_ sp.  
_Turritella ocyana_ Conrad.

The matrix is a fine grained gray sandstone. Isidro (?) formation. The mollusks indicate Temblor, lower Miocene age.

Loc. 66 (L.S.J.U.). Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California; Isidro formation, lower Miocene; B. F. Hake collector.

_Amiantis_ cf. _communis_ Nomland.  
_Metis_ alta Conrad.  
_Mytilus_ cf. _mathewsonii_ Gabb.  
_Sanguinolaria_ _toulai_ Hertlein & E. K. Jordan, new species.  
_Saxidomus_ cf. _vaquerosensis_ Arnold.  
_Calyptrea_ inornata Gabb.  
_Cymia_ _heimi_ Hertlein & E. K. Jordan, new species.  
_Cypraea_ _amandusi_ Hertlein & E. K. Jordan, new species.  
_Crassispira_ _starri_ Hertlein & E. K. Jordan, new species.  
_Macron_ _hartmanni_ Hertlein & E. K. Jordan, new species.  
_Polinices_ _reclusianus_ (Deshayes).
Terebra burckhardti Hertlein & E. K. Jordan, new species.
Thais wittichi Hertlein & E. K. Jordan, new species.
Turritella bōsei Hertlein & E. K. Jordan, new species.
Turritella ocyana Conrad.
Scutella norrisi Pack.
Balanus aff. B. t. californicus Pilsbry.

This fauna shows excellent preservation and occurs in a light colored fine grained sandstone. Isidro formation. The fauna is apparently of lower Miocene age, certainly as old as the Temblor of California and possibly equivalent in part to the upper Vaqueros of California. The general assemblage indicates a lower Temblor age.


Clypeaster aff. deserti Kew.

The species in the present collection seems most closely related to Kew’s species. The preservation of the echinoderm as well as the lithological character of the matrix is typical of the Isidro, lower Miocene.


Balanus sp.

Loc. 71 (L.S.J.U.). Cliff around San Ignacio, Lower California; probably Isidro; B. F. Hake collector.

Ostrea sp.


Chione sp.
Codakia sp.
Glycymeris sp.

*Cardium* cf. *quadrigenerarium* Conrad. (Cast).

Loc. 74 (L.S.J.C.). 1 kilometer southwest of Loc. 72 (L.S.J.U.); 2 kilometers N. 80° west of San Angel, Lower California; lower Miocene; W. P. L. Winham collector, 1921.

*Turritella* cf. *ocoyana* Conrad.

This species also occurs in the Temblor lower Miocene of California where it is very common.

Loc. 101 (L.S.J.U.). Diatomite from the Rancho San Gregorio; (lower Miocene of Marland Oil Company geologists); C. R. Swarts collector.


*Ostrea eldridgei* Arnold.

This species has previously been known only in the Temblor and Vaqueros, lower Miocene formations of California.


*Aetobatus smithii* Jordan & Beal.
*Carcharocles rectus* Agassiz.
*Carcharinus antiquus* Agassiz.
*Carcharodon* sp.

These species also occur in the beds of Temblor age in California.

Loc. 958 (C.A.S.). Miocene beds on east side of Turtle Bay, Lower California, about one-half mile northeast of prominent yellow mesa or monadnock. From thin bed just above contact with older Eocene (?) conglomerates. E. K. Jordan and G. D. Hanna collectors, 1925.
Pecten (Leptopecten) andersoni Arnold.

Hemipristis heteropleurus Agassiz.

Isurus hastalis Agassiz.

These are typical Temblor species of the California Miocene.


Pecten (Leptopecten) andersoni Arnold.

Hemipristis heteropleurus Agassiz.

These beds are apparently equivalent to those at Loc. 958 (C.A.S.).

Correlation

Beds in the Cape Region of Lower California which were thought to be of Miocene age were reported from northeast of Santiago by Gabb in 1868 and 1869. These were assigned to the Miocene because of the presence in them of a large oyster, thought to be Ostrea titan Conrad. Fuchs in 1886 and Saladin in 1892 referred to beds which they thought might be Miocene or Pliocene in age near Boleo, Lower California, but all the collections from there as well as the species reported from that region indicate an upper Pliocene age.

Aguilera in 1896 referred to beds of "Mioceno Superior á Plioceno" age in the southern part of Lower California. Whether this referred to beds of Miocene age or to beds now known to be Pliocene cannot be determined.

Aguilera in 1906 referred to beds of upper Miocene age at Santa Rosalia and Boleo, Lower California; these, how-

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14a Bull. Soc. l'Ind. Min., 3rd Ser., Vol. 6, 1892, p. 10.
ever, are now known to be Pliocene in age. Wittich\textsuperscript{19} in 1909 and 1911 writing on the Geology of the Cape Region described Miocene beds which he thought lay upon granite and were overlain conformably by Pliocene sediments. These lower beds he thought might be Pliocene in age but stated that they had been considered to be of Miocene age by American geologists. Heim\textsuperscript{20} in 1915 described beds of Miocene age in the southern part of Lower California in La Purisima valley. The diatomaceous beds in the Miocene series were referred to the Monterey shale and were reported to be of the same lithologic character as the Monterey shale of California. Dickerson\textsuperscript{21} in 1917 listed Miocene species from Lower California which were later referred to by Arnold and Clark, and by Heim. These species were thought to represent a fauna equivalent to the Bowden Miocene of the Caribbean region and thus to indicate a direct connection with the Caribbean Sea during Bowden Miocene time.

J. P. Smith\textsuperscript{22} in 1919 referred to a Miocene fauna probably of Vaqueros age from near San Gregorio Lagoon on the Pacific coast of Lower California. Arnold and Clark\textsuperscript{23} in 1917 briefly discussed a Miocene collection made by Dr. Heim. The fossils were referred to the Apalachicola horizon of the Caribbean Sea region. Kew\textsuperscript{24} in 1920 described \textit{Cassidulus (Rhynchopygus) mexicanus} from East San Ysidro, Lower California. He stated that the horizon was probably equivalent to the Gatun formation of the Gulf-coastal Plain and referred it questionably to the lower Pliocene. Heim\textsuperscript{25} in 1921 showed on a map three Miocene divisions in the region of La Purisima, Lower California. He mapped the Purisima Nueva formation as questionably Oligocene. In the Miocene he mapped Monterey shale, “grüne Molasse, Sandstein” and “braune Molasse, Konglomerat.” Freudenberg\textsuperscript{26} in 1921 referred to the Mi-

\begin{itemize}
\item \textsuperscript{19} Bol. Soc. Geol. Mex., Vol. 6, pt. 1, 1909, p. 8; Zeit. der Deutschen Geol. Gesellschaft Monatsber., Nr. 12, 1911, pp. 575, 581, 583, pl. 1.
\item \textsuperscript{22} Proc. Calif. Acad. Sci., 4th Ser., Vol. 9, No. 4, 1919, p. 161.
\item \textsuperscript{23} Bull. Geol. Soc. Amer., Vol. 28, 1917, p. 223.
\item \textsuperscript{24} Univ. Calif. Pub. Geol., Vol. 12, No. 2, 1920, p. 141.
\item \textsuperscript{25} Zeit. für Vulcanologie herausgegeben von Imm. Friedlander, Bd. 6, 1921, map pl. 4.
\item \textsuperscript{26} Geologie von Mexiko, Berlin, 1921, p. 133.
\end{itemize}
Miocene beds described by Heim. Darton\textsuperscript{27} in 1921 described Miocene beds in the region of La Purisima and San Ignacio, Lower California. He recognized “Monterey beds” with a thickness of 500 feet and “yellow beds” with a thickness of about 500 feet. He listed fossils which are characteristic of the Miocene of California such as \textit{Pecten crassicardo} Conrad and \textit{Turritella ocyana} Conrad. Darton tentatively correlated the Monterey beds with the Monterey formation of southern California, and the yellow beds were considered on the basis of fossils to belong to the late Miocene.

Wilhelm\textsuperscript{28} in 1921 discussed beds around Miraflores and San Bartoleo on the east side of the southern part of Lower California. These beds contained large oysters and were considered to be Miocene in age. The beds were said to be about 1,000 feet in thickness and made up of fine grained sandstone, clay shales and sundry limestone beds containing the species of large oysters. These strata, he stated, conformably overlie upper Cretaceous strata and are overlain apparently conformably by Pleistocene.

Bustamente\textsuperscript{29} the same year referred to beds in the southern part of lower California as the “grupo de La Purisima” which were thought to be Miocene-Pliocene in age; he stated, however, that he was of the opinion that no Miocene was present there, although regarding this point he was not certain. At one locality, strata said to contain tripoli or chalk were referred to as the “grupo de San Ramón-Paso Blanco” and were considered to be of Eocene age. Heim\textsuperscript{30} in 1922 discussed the Miocene of Lower California and gave additional information concerning the different formations. He stated that the opinion is held by some American geologists that the “Purisima Nueva formation” and the Isidro formation are identical. He, however, was inclined to regard them as separate formations. The report of Arnold and Clark was based upon fossils from the Purisima Nueva formation. The name Monterey formation was used for diatomaceous shales overlying the Purisima Nueva formation. Heim thought an unconformity was present between the two formations but stated that all

\textsuperscript{27} Jour. Geol., Vol. 29, No. 8, 1921, p. 731-741.
\textsuperscript{29} Bol. del Petroleo, Vol 11, No. 6, 1921, pp. 504-511.
\textsuperscript{30} Geol. Mag., Vol. 59, No. 702, 1922, pp. 536-541.
geologists do not agree with him on this point. The name Isidro formation was used for shale and shaly sandstone (Grüne molasse of Heim 1921) overlying the Monterey shale and into which the Monterey grades upward. The Isidro formation according to Heim is at some places conformably and at others unconformably overlain by the Comondu (Braune molasse of Heim 1921) Pliocene formation and by Quaternary conglomerates.

Jordan and Hannibal\(^{31}\) in a paper describing shark teeth in 1923 listed localities of Monterey Miocene age in Lower California.

In a paper compiled from the results of the Marland Oil Company\(^{32}\), published in 1924, the Miocene was mapped under two formations, a diatomaceous, San Gregorio formation and the overlying Isidro formation which has a sandy composition. They also stated that the Isidro shale in the Magdalena Bay region is equivalent to the San Gregorio shale in the Purisima region.

Hertlein\(^{33}\) in 1925, referring to the work of Heim and of Beal, also listed and described pectens, some of which were recognized as belonging to the Miocene.

Hanna\(^{34}\) in 1926 referred to beds of Miocene age at Turtle Bay and thought that the basal Miocene beds there containing shark teeth, sea lion teeth and pectens could be correlated with similar Miocene beds in Kern County, California.

Jordan and Hertlein\(^{35}\) in 1926 described Miocene beds at Turtle Bay which are several hundred feet thick. The base of the Miocene is a layer containing bones and sharks' teeth. The bone bed is overlain by a bed of white siliceous shale about 30 feet thick. The remainder of the series was said to be made up of soft, fine grained sandstone, ash, and impure diatomite rich in fish scales and in casts of foraminifera. The beds were reported as dipping in a general westerly direction about 20\(^{\circ}\). The Miocene series is overlain unconformably by Pliocene beds. The beds at Turtle Bay were considered to be equivalent to similar beds on Cedros Island.

\(^{32}\) Bol. del Petroleo, Vol. 18, No. 1, 1924, pp. 51, 52, map opp. p. 52.
Apparently the strata at the various localities do not differ greatly in age and for the present are considered to be approximately equivalent. The sediment in which the fossils occur is for the most part whitish, medium fine grained sandstone; the sediment as well as the fauna seems to indicate a neritic facies of marine deposition. Correlation of these beds with other deposits is made chiefly on community of diagnostic species and on the presence of certain groups.

The present fauna shows but little affinity with the Miocene fauna of western South America, but it does contain certain forms which show close relationship with the Caribbean Miocene fauna. This is shown by such species as Cymia heimi, and Cypraea amandusi, but in no case in the present collection can the species be definitely identified with those of the Caribbean region. On the other hand the fauna is decidedly western North American in its affinities with about 50% of the identified species identical with those from Miocene formations of California, and it contains a number of other closely related species. Such species as Ostrea eldredgei Arnold, Pecten andersonii Arnold, Pecten crassicardo Conrad, Calyptraea radians Lamarck, Turritella ocoyana Conrad and Isurus hastalis Agassiz are very common and most of them confined to the lower Miocene of California. The evidence of a connection between the Pacific and Caribbean seas has been well shown by Dr. J. P. Smith who pointed out that Caribbean groups such as Lyropecten, Dosinia, giant oysters and Chione of the gnidia group first appeared in the Miocene on the west coast. The present fauna also contains a few Oriental forms such as Rapana.

A preliminary examination of a sample of shale containing fossil diatoms from Loc. 101 (L.S.J.U.), diatomite from the Rancho San Gregorio, Lower California, has been made by Dr. G. Dallas Hanna. The forms found and their relationships are so important from a correlation standpoint that he hopes to prepare a separate report on the deposit in the near future. He states that:

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26 For an excellent discussion of the principles of correlation see C. Diener, Grundzüge der Biostratigraphie, Wien, 1925, pp. 138-156.
28 Written communication.
“The examination which has been made, indicates that the formation is lower Miocene in age and the flora is very different from that recently described from Maria Madre Island\textsuperscript{39}, upper Miocene, a few hundred miles to the southward. There were noted in the study of that material, certain resemblances to east coast Miocene deposits and this relationship was probably as close as it is to the Monterey shale of California, the diatoms of which have been very thoroughly studied and illustrated. The deposit from Loc. 101 (L.S.J.U.), diatomite from the Rancho San Gregorio, Lower California, appears to be very much more closely related to lower Miocene diatom-bearing shales of New Jersey, Maryland and Virginia. The resemblance amounts to identity of species in some noteworthy cases; and it is believed that a close study of the material will disclose numerous species found heretofore only in the east coast deposits mentioned. Certain others are found in lower Miocene deposits of other parts of the world but the resemblance appears to be less close than to those mentioned.”

The writers consider the Miocene fauna discussed in the present paper to be lower Miocene in age and from the present collection the evidence indicates that the fauna is equivalent at least in part to that found in the lower part of the Temblor beds of California which occur in the Temblor basin and the Kern River district\textsuperscript{40}. Possibly they are in part equivalent to the upper Vaqueros\textsuperscript{40a}, but the assemblage as a whole indicates a lower Temblor, lower Miocene age.

Considered as to climatic relations the fauna is composed in great part of warm water types with \textit{Chione}, \textit{Lyropecten}, giant \textit{Ostrea} and giant \textit{Turritella} which are subtropical or tropical forms.


\textsuperscript{40a} By “Vaqueros” is meant the formation containing the fauna listed by J. P. Smith, Proc. Calif. Acad. Sci., 4th Ser., Vol. 9, No. 4, 1919, pp. 160-161.
Notes and Descriptions of Species

1. Chione richthofeni Hertlein & E. K. Jordan, new species

Plate XVII, figures 4, 7, 8

Shell of medium size; subtrigonal; anteriorly concave in front of beaks; lunule large, cordate, striate and bounded by an impressed line; anterior and ventral margins of shell rounded; posterior ventral margin subrounded; posterior margin broadly curved; escutcheon long and narrow; beaks pointed forward; umbos high, well rounded and broadly rounded at their base; very slight flattening of valves bordering posterior margin; valves ornamented by fine even longitudinal sulcate ribs and concentric fringing lamellae which are striate in line with ribs. Left valve (paratype) possesses two anterior and one posterior cardinal, behind the posterior cardinal two long raised ridges occur on the nymph plate. Length 49.8 mm.; height 46.5 mm.; thickness 40.9 mm.


Chione richthofeni differs from Chione gnidia Sowerby\(^{41}\) in possessing fine, even radial ribbing; the rounding of the umbos extends farther toward the posterior margin where the shell slopes rather abruptly to the slight flattening near the posterior margin; furthermore, the present species possesses two posterior cardinal teeth in the left valve.

From Chione tembloreensis Anderson\(^{42}\), C. richthofeni differs in possessing a more rounded posterior ventral margin and in lacking almost completely the prominent flattening of the dorsal margin which is so pronounced in Anderson's species. The rounded posterior ventral margin, the very slight flattening of the dorsal margin of the valves as well as the

\(^{41}\) Thes. Conch., Vol. 2, 1855, p. 709, pl. 154, fig. 25.

fine, even, radial ribbing distinguish *Chione richthofeni* from *C. walli* Guppy\(^{43}\) of the Caribbean Miocene.

Apparently the present species differs from *V. navidadis* Philippi\(^{44}\) in that the beaks are not situated so markedly anterior nor is it elongated dorsally as is the case in the species described by Philippi.

This species is named in recognition of the pioneer work in west coast geology by Baron von Richthofen.

2. **Glycymeris swartsi** Hertlein & E. K. Jordan, new species

Plate XVII, figures 1, 2

Shell fairly large, obliquely ovate, rather strongly inflated; umbos high, subcentral, sculpture consisting of fine concentric lines of growth, and faint radial lines noticed on only a few unweathered parts of the shell and apparently developed mostly near base of shell; valves rounded in front, somewhat produced behind. Length approximately 40 mm.; height 38.2 mm.; width 29.8 mm.

*Holotype:* L.S.J.U. type collection, from Loc. 60 (L.S.J.U.) west side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California; *paratype* No. 2659, Mus. Calif. Acad. Sci., B. F. Hake collector; Isidro(?) formation, lower Miocene.

This species is unlike any other west coast *Glycymeris*. A row of taxodont teeth is present in one of the paratypes. The shape and sculpture of the valves and the circular row of teeth lead the authors to place this species under the genus *Glycymeris* although the shape is not similar to most other western North American species of that genus.

This species is named for Mr. C. R. Swarts, geologist with the Marland Oil Company during their geological exploration work in Lower California.


\(^{44}\) Fos. Terciar, I, Cuartar, Chile, 1887, p. 120, pl. 14, fig. 4.
3. **Ostrea angermanni** Hertlein & E. K. Jordan, new species

Plate XVII, figures 3, 6

Right valve rather small, subquadrate in outline, moderately arched; an unornamented area covers beak and umbonal region, remainder of shell ornamented by 15 to 20 medium fine, well developed radial plications. Interior of valve moderately deep, sloping from margins of shell to point of greatest concavity at center; hinge shows narrow ligament pit running to anterior dorsal edge of shell; dorsal and parallel to this another longer, narrow pit follows posterior dorsal edge of shell; margins of shell marked with small crenulations. Height 46.2 mm.; length 38.9 mm.; greatest diameter of shell 13.1 mm.

**Holotype:** Right valve L.S.J.U. type collection from Loc. 59 (L.S.J.U.), Turritella bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower California, on the trail from Arroyo Mesquital to La Purisima; E. Call Brown collector; Isidro(?) formation, lower Miocene.

*Ostrea angermanni* differs from *O. vespertina* Conrad\(^45\) in possessing a different hinge in which the pits are narrow and run obliquely across hinge to anterior dorsal margin of shell; furthermore, the present species possesses many more and much finer radial plications on the exterior of the valve. From *Ostrea* (*Alectryonía*) *plicata* Chemnitz\(^46\) and *O. edulis* Linnaeus\(^47\), *O. angermanni* can be distinguished by the more numerous and finer radial plications ornamenting the right valve. *O. angermanni* differs from *O. sellaeformis* var. *thomasii* Conrad\(^48\), in that the lower valve of the present species is more quadrate in outline, it is apparently more highly arched and is ornamented by finer ribs. This species is named for Dr. E. Angermann in recognition of his work in Lower California.

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\(^{46}\) See Reeve, Conch. Icon., Vol. 18, 1871, *Ostrea*, pl. 27, figs. 68a, b, c, d.

\(^{47}\) See Reeve, Conch. Icon., Vol. 18, 1870, *Ostrea*, pl. 5, figs. 8a, b, c, d, e, f.

\(^{48}\) See Maryland Geol. Surv., Miocene, 1904, p. 380, pl. 100, figs. 5a, 5b.

September 2, 1927
4. **Ostrea eldridgei** Arnold


Loc. 147 (L.S.J.U.), Arroyo Mesquital, Lower California. This enormously thickened oyster is considered to be characteristic of the Vaqueros and Temblor lower Miocene formations of California.

5. **Ostrea freudenbergi** Hertlein & E. K. Jordan, new species

   Plate XVII, figure 9; plate XVIII, figure 4

Shell elongate, thickness medium, right valve moderately arched, narrow at beak but widening ventrally, made up of flattish layers of shell material which is ornamented by faint, rather small radial plications. Interior of valve under beak possesses a ligament pit which is rather prominent, long, fairly broad and moderately impressed; concavity of shell moderately deep, just ventral to ligament pit but becoming flatter toward the ventral margin; ventral muscle scar fairly large, impressed and located on the anterior side of the shell about a third of the length of shell from the ventral margin. Height 88.5 mm.; length 61.1 mm.; greatest diameter 21.1 mm.

**Holotype:** Right valve (L.S.J.U. type collection), from Loc. 59 (L.S.J.U.), Turritella bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower California, on the trail from Arroyo Mesquital to La Purisima; E. Call Brown collector; Isidro (?) formation, lower Miocene.

**Ostrea freudenbergi** can be distinguished from *O. chilensis* Philippi[49] and other west coast Ostreas by its only moderately high right valve, elongate shape, faint radial ornamentation, differently shaped ligament pit and long, narrow beaks.

This species is named for Dr. Wilhelm Freudenberg in recognition of his contributions to the knowledge of the geology of Mexico.

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6. Ostrea sp.

Plate XIX, figures 3, 6

Several left valves of an Ostrea were found at Locs. 57 and 71 (L.S.J.U.) which probably do not belong to Ostrea freundenbergi and could not be referred with certainty to any known Ostrea. The valves are long, narrow, fairly smooth, slightly curved and bear a distinct raised area under the beaks. Nearly all these left valves possess exteriorly a groove running from middle of the shell to the anterior ventral edge of the valve.

_Plesiotype:_ Left valve (L.S.J.U. type collection), from Loc. 57 (L.S.J.U.), _La Purisima cliffs, San Ramon River, Lower California_; E. Call Brown collector; Isidro(?) formation, lower Miocene.

7. Pecten (Lyropecten) crassicardo (Conrad)


_Pecten (Lyropecten) crassicardo_ (Conrad), Arnold, Prof. Paper U. S. Geol. Survey 47, 1906, p. 71, pl. 16, figs. 1, 1a; pl. 17, figs. 1, 1a, 1b; pl. 18, figs. 1, 2, 2a.

Loc. 57 (L.S.J.U.), _La Purisima Cliffs, Lower California_; 1 specimen.

This is the specimen recorded by Hertlein⁶⁰ as “_Pecten (Lyropecten) near crassicardo_ (Conrad).” The specimen can be definitely identified with that species. It shows no affinities with the large east American Lyropectens, _P. jeffersonius_ Say and _P. madisonius_ Say⁶¹, other than those shown by typical specimens of _P. crassicardo_ (Conrad).

8. Pecten (Plagioctenium) diminutivus

Hertlein & E. K. Jordan, new species

_Pecten (Plagioctenium) calli_ Hertlein, Proc. Calif. Acad. Sci., 4th Ser., Vol. 14, No. 1, 1925, p. 16, pl. 4, figs. 5 and 7; “west side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California;” not _Pecten calli_ Hertlein, pl. 4, fig. 6, “first arroyo east of Santiago, Lower California.”

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Shell small, right valve fairly flat and ornamented by 16 flattish topped to broadly rounded ribs which are separated by flattish bottomed interspaces which are very slightly narrower than the ribs; right ear well developed with strong byssal notch. Left valve convex with fairly high and rather sharp umbo, and ornamented by 15 to 16 ribs. Altitude 8 mm.; longitude 8 mm.; thickness 2.1 mm.; apical angle, approximately 98°.

Holotype: No. 125 (L.S.J.U. type collection), from Loc. 60 (L.S.J.U.), west side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California; B. F. Hake collector; Isidro formation, lower Miocene.

The writers52 have previously pointed out that the Miocene species figured by Hertlein cannot be referred to Pecten calli Hertlein. It is small and may possibly be the young form of some described species, but several specimens have been found, and it seems best to refer to them with a definite name; Pecten (Plagioctenium) diminutivus is proposed.

The species differs from other west coast Plagiocteniums in its small size and flattish right valve.

9. Pecten (Lyropecten) pretiosus Hertlein


This species appears to be closely related to P. condylomatus Dall53 but can not be definitely assigned to that species. It differs from specimens of the latter in the collections of the California Academy of Sciences in smaller size, the right valve is higher at the umbo and the ribs are lower, evenly rounded and ornamented by numerous fine striae. The valves in P. pretiosus usually show but slight areas comparable to the strong constrictions often found in P. condylomatus.

10. **Sanguinolaria toulai** Hertlein & E. K. Jordan, new species

Plate XX, figure 2

Shell large, thin, fairly compressed, subovate, outline similar to *S. nuttallii* Conrad; ventral margin evenly rounded; beaks small, acute; nymph prominent; two prominent cardinal teeth in left valve; faint groove on anterior dorsal margin of left valve; valves elongated posteriorly, ornamented by concentric lines of growth. Length (extreme ends of shell missing) 91.5 mm.; height 74.2 mm.

*Holotype:* (L.S.J.U. type collection) from Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California; B. F. Hake collector; Isidro formation, lower Miocene.

*Sanguinolaria toulai* is larger and rounder than *S. nuttallii* Conrad and *S. orcutti* Dall. The right valve is more convex and less triangular at the beaks and both valves are apparently more nearly equally inflated than is the case in *S. nuttallii*. *S. toulai* appears to lack any marked concavity on the anterior dorsal margins or any subangular line running from the beaks to the posterior end of the shell.

This species is named for Dr. Franz Toula in recognition of his contribution to the knowledge of the Tertiary of the Panama region.

11. **Saxidomus** cf. **S. vaquerosensis** Arnold


Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California; one specimen.

*S. vaquerosensis* Arnold has previously been found in the lower Miocene of California.

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12. **Calliostoma hannibali** Hertlein & E. K. Jordan, new species

Plate XXI, figures 8, 9

Shell small, rather thin, conical, imperforate; tip of spire missing, four and one-half whorls present in type specimen; whorls sloping and broadly rounded to near periphery where a small angular shoulder is present; from shoulder, whorls slope abruptly to base; body whorl rounded at periphery; near base whorls ornamented by a raised spiral line; on next to last whorl a raised spiral line occurs midway between suture and angular shoulder; whorls ornamented by numerous fine spiral lines which are strongest on base of body whorl. Height approximately 20.5 mm.; width of body whorl 12.5 mm.; apical angle approximately 83°.

*Holotype:* (L.S.J.U. type collection) from Loc. 66 (L.S.J.U.), in *San Ignacio Arroyo, 8 kilometers southwest of San Ignacio, Lower California;* B. F. Hake collector; Isidro formation, lower Miocene.

*Calliostoma hannibali* differs from *C. eximium* Reeve⁵⁶ in possessing a lower spire, whorls which are more sloping and which are rounded at the periphery, and in possessing finer spiral sculpture.

This species is named for Mr. Harold Hannibal in recognition of his contributions to the stratigraphy of western North America.

13. **Crassispira starri** Hertlein & E. K. Jordan, new species

Plate XXI, figure 7

Shell small, elongate conic, fairly solid; spire turrited, probably of six or seven whorls, the tip of the spire lost; whorls flattened, sharply shouldered near the summit, with a pronounced beaded sutural band; axial sculpture of about 21 strong, narrow, sharp, straight, slightly protractive ribs, which become very slightly enlarged on the shoulder, and end

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⁵⁶ Proc. Zool. Soc., 1842, p. 185; Tryon Man. Conch., Vol. 10, 1888, pl. 41, fig. 28; Vol. 11, 1889, p. 366, pl. 65, figs. 84-86.
in prominent rounded beads on the sutural band; spiral sculpture nearly obliterated in type specimen, but apparently of many fine, impressed lines; base long, not inflated, sculptured by continuations of the axial ribs, and apparently by fine spiral lines; aperture elongate-ovate, produced anteriorly into a fairly long canal; inner and outer lip with a small sinus posteriorly. Length (of last three whorls and canal) 19 mm.; width 8.4 mm.

*Holotype:* L.S.J.U. type collection from Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California; B. F. Hake collector; Isidro formation, lower Miocene.

The strongly beaded sutural band of this species is its most striking characteristic. It differs from *Drillia (Crassispina) bōsei* Engerrand & Urbina\(^{37}\) in possessing a very strong, beaded band, much more sharply shouldered whors and very faint spiral sculpture. The present species appears to differ from *Pleurotoma (Drillia) dalli* Toula\(^{38}\) in that the whors are more sharply shouldered at their summits and possess much finer spiral sculpture than is the case in the species described by Toula.

This species is named for Dr. David Starr Jordan, Chancellor Emeritus of Leland Stanford Junior University.


*Plate XVIII, figure 5*

Shell large, thick and heavy, rather elongate; spire of about five whors appressed at the sutures, the sides roughly flat; sutures wavy; body whorl and next to last whorl ornamented at the periphery by a row of strong, rounded nodes which are not prolonged into axial ribs; about eight or nine of these nodes on the body whorl; nodes not appearing from beneath the sutures until the next to the last whorl, the early whors bearing neither nodes nor axial ribs; spire and base ornamented by many unequal and unequally spaced rather fine


\(^{38}\) Jahrbuch der K. K. Geol. Reichsanstalt, Bd. 61, Nos. 3 and 4, 1911, p. 506, pl. 30, fig. 12.
impressed spiral grooves, these grooves underlain on the base and to some extent on the spire by vague, broad, distantly spaced spiral ridges; about 22 grooves between the periphery and the suture on the late whorls; aperture elongate, ovate, opening into a canal at each end; outer lip spirally ridged internally, the ridges ending in about eleven blunt nobs; inner lip with a strong blunt plait at about the middle, and another close to the anterior end of the aperture. Height 80.0 mm.; width 50.8 mm.; height of spire above body whorl about 30 mm.


Five other specimens of this species were examined from the type locality, and one from Loc. 59 (L.S.J.U.), Turritella bed above San Gregorio Lagoon.

Apparently the nearest relative of this species is *C. henekeni tectiformis* Pilsbry, from the lower Miocene of Santo Domingo. From that species *C. heimi* appears to be distinguished by having a larger, heavier and somewhat narrower shell, with the nodes on the periphery a little broader and less sharp. From *C. tectum* Wood, a somewhat similar west American species of the genus, both the present species and its Caribbean analogue differ in bearing many fine spiral grooves between the periphery and the suture rather than the few (10-12) deeply impressed grooves separating broad, flat-topped spiral ridges that characterize *C. tectum*.


Plate XVIII, figure 1; plate XIX, figures 1, 4, 5

Shell moderately large; resembles *C. mus* var. *bicornis* Sowerby; somewhat pear-shaped; dorsal margin very broadly rounded, in some specimens subsquare, margin cut by notch; dorsal surface of shell bears usually two nodes, one on each

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side of median dorsal line; posterior dorsal portion of shell noticeably depressed below the two nodes; highest part of shell anterior to nodes; some specimens slightly corrugated chiefly posteriorly; ventral portion of shell flattish; aperture curved and ornamented by about 20 to 22 teeth. Length 57.3 mm.; width 41 mm.; height 26.5 mm.


*Cypraea amandusi* differs from *C. hennekeni* Sowerby in possessing a much flatter shell and also in the presence of a depressed area in the dorsal posterior portion of the shell. From *C. mus* var. *bicorns* Sowerby, *C. amandusi* differs in its larger size and in possessing a much flatter, less corrugated shell; in the latter strong nodes surmount ridges which run to the edge of the dorsal margin of the shell.

This species is named for Dr. Rudolph Amandus Philippi whose work added greatly to the knowledge of paleontology and conchology.


Plate XVIII, figure 2; plate XXI, figure 5

Shell of moderate size, very thick and solid, ovate in outline; spire elevated, the apex acute; whorls about five, moderately inflated, separated by deeply and broadly channeled sutures, the later whorls strongly shouldered at the summit; spiral sculpture consisting of a deep groove around the body whorl a little below the periphery, below which on the base are three or four narrow spiral grooves, and above which on main part of whorls are six to ten similar grooves that diminish in intensity anteriorly, the summit of the whorls without spiral sculpture; base concave below periphery, swelling toward the umbilical area into a large siphonal fasciole; umbilical area

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62 See Tryon, Man. Conch., Vol. 7, 1885, p. 177, pl. 10, fig. 43.
subperforate; aperture ovate, produced into a short canal below, and also notched at the upper end, surrounded by thickened and callused lips; outer lip bearing a short blunt tooth at intersection with subperipheral spiral groove. Height 47 mm.; width 29 mm.


Eleven other specimens of this species were examined from the same locality.

This species is closely related to *M. merriami* Arnold, from the lower Miocene of southern California, but it seems to differ from that species in several particulars. The type of *M. merriami* is small, while the present species attains a much greater size, the largest specimen in the collection being 65 mm. in height. *M. merriami* lacks all spiral grooving anterior to the periphery, lacks the very strong shoulder at the summit of the whorls, lacks the deep concavity of the base just below the periphery, and is in general a more simple and less strongly marked shell. The pronounced development of many of these characters, however, including of course that of size, seems to a considerable extent to be a matter of age, and young examples of *M. hartmanni* differ little from *M. merriami*. *Macron hartmanni* has more numerous and much finer spiral grooves than either of the recent Lower California species, *M. kellettii* A. Adams and *M. æthiops* Reeve.

17. Polinices (Neverita) recluzianus (Deshayes)

*Natica recluziana* Deshayes, Mag. de Zool., Mollusca, 1841, pl. 37, “Mers de Californie.”


*Neverita recluziana* (Deshayes), Dall, U. S. Nat. Mus., Bull. 112, 1921, p. 165.

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64 Tryon Man. Conch., Vol. 3, 1881, p. 214, pl. 82, fig. 477.
Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California; Isidro formation, lower Miocene.

This extremely variable species is recorded as extending in the west American Tertiary from the Oligocene to the recent. It is not attempted at this time to place in the synonymy the considerable number of alleged species, subspecies and varieties described by various authors as distinct from typical *P. reclusianus*, many of which fall without question within the range of variation of the single species. Several variants are represented in the present collection. According to Dall the range of *Polinices reclusianus* is at the present time from Crescent City, California, to the Tres Marias Islands and Chile.

18. **Rapana imperialis** Hertlein & E. K. Jordan, new species

Plate XX, figure 1

Shell large, strong, thick and heavy; spire low, broad, of about five whorls, the sides flattened; whorls strongly shouldered at a considerable distance below the summit; shoulder ornamented by a series of large, hollow, slightly curved horns, about nine such horns on the body whorl; periphery marked by a heavy, blunt spiral ridge, feebly nodose, the nodes roughly corresponding to the horns at the shoulder of the whorl; base concave, bearing about four strong, blunt, roughly squamose spiral ridges; no axial sculpture on spire or base other than rather pronounced incremental lines; a prominent siphonal fasciole encircling a wide open umbilicus; aperture large, opening anteriorly into a small recurved canal. Height 110 mm.; maximum width 105 mm.


This magnificent shell is close to *Rapana vaquerosensis* Arnold⁶⁶ of the lowermost Miocene of upper California but

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⁶⁶ Smithson. Misc. Coll., Vol. 50, 1908, p. 427, pl. 52, figs. 1a, 1b.
differs chiefly in being proportionately broader, with a less elevated spire, and in bearing fewer and much stronger horns on the shoulder of the whorls. These horns give the shell a strikingly coronate appearance.

19. **Terebra burckhardti** Hertlein & E. K. Jordan new species

Plate XXI, figure 6

Shell moderately slender, spire missing, four and one-half whorls present in type specimen; outline of whorls straight on sides; below suture each whorl possesses a somewhat convex projecting sutural band which is set off from remainder of whorl by a sharp, incised line; each whorl sculptured by about 18 longitudinal plications which run slightly oblique and offset slightly on crossing to the sutural band where they are coarser; on body whorl, plications bend slightly anteriorly at top of whorl and slightly posteriorly at base of whorl; canal unornamented. Length 25.5 mm.; width of body whorl 9.3 mm.


*Terebra burckhardti* differs from *T. variegata* Gray in possessing a stronger projecting sutural band, stronger longitudinal plications, and sharper shouldered whorls. It is distinguished from *T. dislocata* Say, *T. aspera* Hinds and *T. acuaria* Toula, by possessing coarser ribs, strong projecting collar and in lacking spiral ornament. From *T. gausapata herviderana* Spiucker, *T. burckhardti* can be distinguished by the absence of the spiral sculpture which is so pronounced in

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67 See Tryon, Man. Conch., Vol. 7, 1885, p. 14, pl. 1, figs. 5, 7, 8; pl. 2, figs. 15, 19, 21; pl. 3, figs. 31, 37, 38.
68 Jahrbuch d. K. K. Geol. Reichsanstalt, Bd. 61, Heft 3 & 4, 1911, p. 505, pl. 31, figs. 19a, b, c.
69 Johns Hopkins Univ. Studies in Geol., No. 3, 1922, p. 35, pl. 1, fig. 1.
Spieker's subspecies. Furthermore the present species possesses a more slender shell than does Spieker's subspecies. *Terebra burckhardti* differs from *T. (Myurella) coleri* Enger- 
auld & Urbina\(^9\) in lacking spiral sculpture on the whorls, in the absence of plaits on the columnella and apparently in possessing more sharply shouldered whorls that *T. coleri*.

This species is named for Dr. Carlos Burckhardt in recognition of his excellent contributions to the knowledge of the paleontology and stratigraphy of Mexico.

20. **Thais wittichi** Hertlein & E. K. Jordan, new species

Plate XVIII, figure 3

Shell rather large, thick and solid, moderately elongate; spire moderately elevated, of six slightly inflated whorls separated by fairly well defined sutures; whorls vaguely shouldered at some distance anterior to the summit, crossed by six to eight strong varices which are somewhat produced at the shoulder; also sculptured between the suture by 10 to 20 low, unequal spiral ridges separated by narrowly impressed grooves, the spiral sculpture continuous across the varices; base rather long, ornamented by continuations of the varices and by spiral sculpture similar to that of the earlier whorls; umbilicus narrow but plainly open; a prominent siphonal fasciole; aperture broadly ovate, produced anteriorly into a rather long, narrow, straight canal, which in old specimens tends to be partially covered over; inner lip rather heavily callused; outer lip thickened and bearing seven to nine strong knobs within.


Fifteen other specimens of this species were examined from the same locality where it is apparently abundant.

\(^9\) Bol. Soc. Geol. Mex., T. 6, 1910, p. 120, pl. 59, figs. 35, 36.
This fine species is apparently totally different from any of the genus known from the Miocene of western North America, from the Peruvian region, or from the Caribbean region.

This species is named for Dr. Ernest Wittich whose work has added to the knowledge of the geology of Lower California.

21. Turritella bösei Hertlein & E. K. Jordan, new species

Plate XXI, figures 1, 2

Shell large, long; early whorls similar to T. ocoyana but later with a strong, projecting carina at point of greatest diameter; whorls slightly concave above carina; point of greatest concavity occurs at about one-third the length of whorl from top of whorl; whorls ornamented above carina by about 6 or 7 strong, subequally spaced lines; below point of greatest diameter two spiral lines ornament whorl; spiral lines increase in prominence in later whorls where they are crossed by oblique lines of growth; base of body whorl ornamented by 7 to 8 spiral lines. Length (earliest whorls missing) 143 mm.; greatest width of body whorl 38 mm.


Turritella bösei differs from T. ocoyana Conrad\(^1\) to which it is closely related, in possessing a projecting carina on most of the whorls at the point of greatest diameter; also the whorls above the carina are slightly concave and ornamented by stronger spiral sculpture. From T. supraconcaza freadi Hodson\(^2\), T. bösei differs in possessing somewhat coarser and

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\(^1\) Pac. R. R. Rept., Vol. 5, 1857, p. 329, pl. 8, figs. 73, 73a, 73b.

\(^2\) Bull. Amer. Paleol., Vol. 11, No. 45, 1925, p. 135, pl. 21, fig. 94, from Cretaceous of California.\)
less numerous spiral lines. Furthermore the whorls are more convex above the carina in *T. bösei* than in Hodson’s subspecies and the whorls in the present species slope much more abruptly from the carina anteriorly to the suture. The carina in *T. bösei* does not project so far and it is not so sharp as *T. s. freadi*.

From *T. subgrundifera* Dall²⁹, *T. bösei* differs in its larger size, in possessing heavier spiral lines in the later whorls, and in that the whorls are slightly concave above the carina. *T. bösei* has two spiral lines below the carina which are separated by a wider interspace and both are nearer the suture than are the corresponding lines in Dall’s species.

This species is named for Dr. Emil Böse in recognition of his contributions to the geology and paleontology of Mexico.

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Plate XXI, figures 3, 4

Shell long, fairly slender; 7 subconvex whorls present, several early whorls missing in type specimen; from suture whorls slope outward to greatest diameter which occurs about one-third the length of whorl from base, point of greatest diameter marked by a fairly strong spiral rib below which whorls slope rather abruptly to suture; above rib marking greatest diameter are 4 to 6 well defined equidistantly spaced, spiral ribs, in some whorls a tiny midrib occurs between the strong carinal rib and first rib above; immediately below point of greatest diameter an interval of space occurs below which three equidistantly spaced fine spiral lines occur; on base of body whorl the lowest of these lines marks a subangular shoulder, below which the base is ornamented by several fine spiral lines. Body whorl also ornamented by lines of growth which cross the spiral sculpture obliquely; in early whorls growth lines are very slight or lacking. Height 86 mm.; greatest diameter of body whorl 24 mm.

Holotype: L.S.J.U. type collection, from Loc. 59 (L.S.J.U.), Turritella bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower California, on the trail from Arroyo Mesquito to La Purisima; paratypes L.S.J.U. type collection and Nos. 2682, 2683 and 2684, Mus. Calif. Acad. Sci., from Loc. 59 (L.S.J.U.); E. Call Brown collector; Isidro(?) formation, lower Miocene.

Turritella wittichi in its earlier whorls resembles T. ocoyana Conrad, but it differs in that the point of greatest diameter occurs at about one-third the length of whorl from base while in T. ocoyana, the greatest width of whorl is usually near the base.

Turritella wittichi differs from T. nelsoni var. rotundata Grzybowski in lacking the numerous fine secondary spiral ribs, and in that the base of the whorls slope more abruptly to the suture, furthermore T. nelsoni var. rotundata possesses four lines below the carina while only three are present in T. wittichi. Apparently the early whorls are more subangular in T. wittichi than in T. nelsoni var. rotundata.

From T. venezuelana Hodson, T. wittichi differs in possessing more numerous and much fainter spiral ribs, furthermore the whorls bear three fine spiral lines anterior to point of greatest diameter, while in Hodson’s species but one strong spiral rib is present. T. wittichi differs from T. tristis Brown & Pilsbry in possessing more numerous spiral ribs, the point of greatest diameter occurs about one-third the length of whorl from base, and the base of whorls is ornamented by three fine spiral lines. T. wittichi can be distinguished from T. infracarinata Grzybowski by the finer ribs in the present species, and in that the point of greatest diameter is about one-third the length of whorl from base, and three fine lines orna-

14 Neues Jahrbuch für Miner. Geol. u. Paleo. Beil. Bd. No. 12, 1899, p. 643, pl. 20, fig. 6; see also Spieker, Johns Hopkins University Studies in Geol., No. 3, 1922, p. 77, pl. 3, fig. 7.
15 Bull. Amer. Paleol., Vol. 11, No. 45, 1926, p. 32, pl. 21, figs. 4, 8; pl. 22, figs. 1, 6.
17 Neues Jahrbuch für Miner. Geol. u. Paleo. Beil. Bd. 12, 1899, p. 643, pl. 20, fig. 5; see also Spieker, Johns Hopkins Studies in Geol., No. 3, 1922, p. 79, pl. 3, figs. 9 and 10.
ment the anterior part of whorl between point of greatest diameter and suture.

*T. wittichi* differs from *T. gatunensis* Conrad in its larger size, in possessing differently shaped whorls, fainter ribbing, and in possessing only one strong rib on the wider part of the whorls.

This species is named for Dr. Ernest Wittich in recognition of his contributions to the knowledge of the geology of Lower California.

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\(^7\) Pac. R. R. Rept., Vol. 6, p. 72, pl. 5, fig. 20; also Dall, Trans. Wag. Inst., Vol. 3, pt. 2, 1892, p. 310, pl. 17, fig. 10.
Fig. 1. *Glycymeris swartsi* Hertlein & E. K. Jordan, new species; natural size; paratype, left valve. No. 2659 (C.A.S. type coll.), from Loc. 60 (L.S.J.U.), west side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California: Isidro (?) formation, lower Miocene; p. 620.

Fig. 2. *Glycymeris swartsi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 620.

Fig. 3. *Ostrea angermannii* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from Loc. 59 (L.S.J.U.), Turritella bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower California. Isidro (?) formation, lower Miocene; p. 621.

Fig. 4. *Chione richlhofeni* Hertlein & E. K. Jordan, new species; natural size; paratype, (L.S.J.U. type coll.), from Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California. Isidro formation, lower Miocene; p. 619.

Fig. 5. *Isurus hastalis* Agassiz; natural size; plesiotype, (C.A.S. type coll.), from Loc. 958 (C.A.S.), east side of Turtle Bay, about one half mile northeast of prominent yellow mesa or monadnock, Turtle Bay, Lower California; lower Miocene; p. 609.

Fig. 6. *Ostrea angermannii* Hertlein & E. K. Jordan, new species; natural size; same specimen as fig. 3; p. 621.

Fig. 7. *Chione richlhofeni* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 4; p. 619.

Fig. 8. *Chione richlhofeni* Hertlein & E. K. Jordan, new species; natural size; same specimen as fig. 7; p. 619.

Fig. 9. *Ostrea freudenbergi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 3; p. 622.
Plate 18

Fig. 1. *Cytraea amandusi* Hertlein & E. K. Jordan, new species; natural size; syntype, (L.S.J.U. type coll.), from Loc. 66 (L.S.J.U.), San Ignacio Arroyo, 8 kilometers southwest of San Ignacio, Lower California. Isidro formation, lower Miocene; p. 628.

Fig. 2. *Macron hartmanni* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 629.

Fig. 3. *Thais wittichi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 633.

Fig. 4. *Ostrea freudenbergi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), same specimen as Pl. 17, fig. 9; p. 622.

Fig. 5. *Cymia heimi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 627
Plate 19

Fig. 1. *Cypraea amandusi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from Loc. 66 (L.S.J.U.), San Ignacio Arroyo, 8 kilometers southwest of San Ignacio, Lower California. Isidro formation, lower Miocene. Same specimen as Pl. 18, fig. 1; p. 628.

Fig. 2. *Turritella ocoyana* Conrad; natural size; plesiotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 608.

Fig. 3. *Ostrea* sp.; natural size; plesiotype, left valve, (L.S.J.U. type coll.), from Loc. 57 (L.S.J.U.), La Purisima cliffs, San Ramon River, Lower California. Isidro formation, lower Miocene; p. 623.

Fig. 4. *Cypraea amandusi* Hertlein & E. K. Jordan, new species; natural size; paratype, No. 2663 (C.A.S. type coll.), from same locality as fig. 1; p. 628.

Fig. 5. *Cypraea amandusi* Hertlein & E. K. Jordan, new species; natural size; paratype, No. 2664 (C.A.S. type coll.), from same locality as fig. 1; p. 628.

Fig. 6. *Ostrea* sp.; natural size; plesiotype, (L.S.J.U. type coll.). Same specimen as fig. 3; p. 623.
Plate 20

Fig. 1. *Rapana imperialis* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from Loc. 57 (L.S.J.U.), La Purisima cliffs, San Ramon River, Lower California. Isidro (?) formation, lower Miocene; p. 631.

Fig. 2. *Sanguinolaria toulai* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California. Isidro formation, lower Miocene; p. 625.
Plate 21

Fig. 1. *Turritella bosei* Hertlein & E. K. Jordan, new species; natural size; syntype, (L.S.J.U. type coll.), from Loc. 66 (L.S.J.U.), Arroyo San Ignacio, 8 kilometers southwest of San Ignacio, Lower California; Isidro formation, lower Miocene; p. 634.

Fig. 2. *Turritella bosei* Hertlein & E. K. Jordan, new species; natural size; syntype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 634.

Fig. 3. *Turritella wittichi* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from Loc. 59 (L.S.J.U.), Turritella bed above San Gregorio Lagoon, 120 miles north of Magdalena Bay, Lower California; Isidro (?) formation, lower Miocene; p. 635.

Fig. 4. *Turritella wittichi* Hertlein & E. K. Jordan, new species; natural size; paratype, No. 2682 (C.A.S. type coll.), from same locality as fig. 3; p. 635.

Fig. 5. *Maccon hartmanni* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; same specimen as Pl. 18, fig. 2; p. 629.

Fig. 6. *Terebra burckhardti* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 632.

Fig. 7. *Crassispira starri* Hertlein & E. K. Jordan, new species; natural size; holotype, (L.S.J.U. type coll.), from same locality as fig. 1; p. 626.

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Fig. 10. *Turritella* sp.; natural size; plesiotype, (L.S.J.U. type coll.), from Loc. 60 (L.S.J.U.), west side of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California; lower Miocene; p. 608.
NOTES ON NEW OR RARE FISHES FROM HAWAII

BY

DAVID STARR JORDAN
BARTON WARREN EVERMANN
AND
SHIGEHO TANAKA

The authors spent sometime in Hawaii in the fall of 1925 in connection with the establishment of the Pan-Pacific Research Institution developed by the Pan-Pacific Union, of which Mr. Alexander Hume Ford is the efficient secretary. In frequent visits to the prolific markets of Honolulu, Doctors Jordan and Evermann made a large collection of fishes for the museum of the California Academy of Sciences.

This collection has been studied jointly by the present writers and by Dr. Yojiro Wakiya, director of the Fisheries Experimental Station of Korea. Jordan and Evermann, while in Honolulu, made, usually, daily visits to the fish markets where they examined in as much detail as possible, the catch of the various fishermen as brought in and put on sale, purchasing or otherwise securing specimens thought to be new or rare, and taking measurements and life-color notes.

Doctors Tanaka and Wakiya each spent several months in the winter of 1925-26 at Stanford University where Dr. Wakiya paid special attention to the Carangidae. He wrote up the species of *Uraspis* and *Leucoglossa* and compared them with Japanese examples. Dr. Tanaka went over the entire
collection, the Carangidae excepted, verifying Jordan and Evermann's field notes and descriptions. All the keys were drawn up by Dr. Jordan and tested by Dr. Evermann.

Many courtesies were extended to us in connection with our visits to the Honolulu fish market. First of all, we must mention Mr. J. E. Illingworth, entomologist, of the Bishop Museum, who came early every morning with his car to take us to the markets. Dr. Frederick G. Krauss, professor of Agronomy, University of Hawaii, photographed for us several specimens of fishes. Dr. Stanley Ball, curator of collections, Bishop Museum, extended many courtesies in connection with our examination of the collections in that institution. To Dr. C. H. Edmondson, professor of Zoology, University of Hawaii, and Dr. Oestergaard, in charge of the sea-side Biological Laboratory at Waikiki Beach, we are under many obligations for permission to use their laboratory in preserving and caring for our specimens. Mr. F. A. Potter, director of the Waikiki Aquarium, aided us materially in connection with our examination of the fishes in that institution. And we must not fail to mention our old Chinese friend, W. K. Alana, fish dealer in the Honolulu market, who, on each of our many visits to Honolulu in the past 24 years, has never failed to help us in every way possible in securing new or rare specimens. To all these and others who aided us in any way we wish to express our grateful appreciation.

One feature of the local fauna may be especially noted. Nearly all collections in Hawaii have been made in the summer. With October a considerable change takes place, and many of the rare species, especially of Carangidae, appear in abundance, coming in from the open sea or from farther south. The chief fisheries are now carried on by Japanese, who venture out to sea much farther than ever did the Hawaiians who seldom went beyond the coral reefs, where reefs exist. The fauna of the reefs is much less abundant than in the period of the first extensive explorations, those of Dr. Oliver P. Jenkins in 1889, and of Jordan and Evermann in 1901. Probably no species has been actually exterminated by overfishing, but many once common have now become rare.

The type specimens of the species here described are in the Museum of the California Academy of Sciences.
Family Aëtobatidæ

1. Aëtobatus narinari (Euphrasen)
   Hawaiian name, Hihimunau

   A huge example weighing 200 pounds seen in the market. The teeth 21/14, of a clear dark purple-blue. Color light brown; spots everywhere, light yellowish, paler than in young. The monstrous jaws of this example are now in the Museum of the California Academy of Sciences.

Family Belonidæ

Thalassosteus Jordan, Evermann & Tanaka, new genus

_Type:_ Belone appendiculata Günther.

This genus is an ally of Tylosurus, with which it agrees in general characters, differing especially in the presence of a very peculiar bony keel on the lower side of the tip of the lower jaw. This keel is about half deeper than long, its length about 1.7 in eye. The bones in this genus are all intensely green in life, the color more intense than in any other of the Belonidæ. The dorsal and anal are many-rayed, the anterior lobe of each high and falcate.

(θa'λaσσa, sea-green; 'oστε'oν, bone).

2. Thalassosteus appendiculatus (Günther)

A single large example, 1.05 meters long.

Head 1.46 in trunk; depth 5.74; width of head 1.16 in its depth; eye 2.18 in postorbital part of head, 1.2 in interorbital space, 5.26 in snout; pectoral 3.6 in head; ventral 4.27; D. 25; A. 23; P. 13; V. 6; scales about 570 in a longitudinal series to base of caudal; keel on lower jaw ½ diameter of eye; snout nearly twice rest of head.

Body very elongate, strongly compressed, the sides flattened; caudal peduncle depressed, flattened above and below; head slightly deeper than wide, flattened at tip, the sides strongly compressed, under surface narrowly constricted; eye rather large, longer than deep, combined length of eye and postorbital part of head 1.6 in jaws; interorbital broad, slightly concave across; nasal cavity large, close to eye; jaws
long, subequal, rather slender; lower jaw with a large and very peculiar keel below at tip, compressed laterally; cleft of mouth extending to below center of eye; teeth in jaws strong canines, present to tip, intermingled with very small acute teeth; no vomerine teeth; gill-openings large, the membranes continued forward below, separate, free from the isthmus which is long and narrow; no gillrakers; pseudobranchiae small but developed. Dorsal fin inserted nearer origin of ventral than base of caudal, anterior rays longest, so that anterior portion of fin becomes a falcate lobe, posterior rays short, subequal, last ray a little longer; anal inserted below origin of dorsal, similar in form to dorsal fin but the last rays not produced; pectoral rather small, as long as postorbital part of head, its upper rays longest, the posterior margin obliquely rounded; ventrals inserted slightly nearer base of caudal than posterior rim of eye; caudal deeply lunate, the lower lobe much the longer; caudal peduncle keeled on either side at base of caudal.

Scales small, slightly imbricate; cheeks thickly scaled; front of opercle narrowly scaled; lateral line running low and posteriorly close above the keel on either side of caudal peduncle.

Color in spirits, upper third of body dark greenish (in life peculiarly bright green), lower part whitish; between these two colors a broad silvery bluish longitudinal band present; head mostly gray, bluish black above; lower parts whitish; teeth and jaws including the keel of lower jaw a very deep green more intense than in any related species; vertical fins all dusky, deeply tinged with bluish and dark-tipped; caudal with dark posterior margin; pectoral dusky tinged with bluish; ventral dark, similar, with blue; lateral band white in life.

The single specimen seems to be identical with Belone appendiculata, described by Dr. Günther, from Solomon Islands.

3. Ablennes hians (Cuvier & Valenciennes)

Three specimens 740 to 770 mm. long. D. 24 or 25; A. 27. Dorsal high, very acutely falcate, its depth 2.75 in head, posterior rays high; anal similar in form to dorsal, posterior rays long, but not so long as the corresponding rays in dorsal; anal inserted a little in advance of
origin of dorsal, the latter fin inserted above seventh to ninth ray of anal. Jaws not closing, the upper at base curved upward; thickness of body a little more than half depth; no keel at caudal base.

Color in life, dark green, sides abruptly silvery; black half-bars 4-7 in number (12 to 14 *tide* Regan), varying in number and size, but quadrate in form; no green on head, nor on jaws and teeth; falcate part of dorsal and anal dusky, tips much darker, posterior rays of the former fin blackish, with darker distal parts, while the corresponding rays of anal are whitish, with no trace of darker.

This species is not uncommon in Hawaii. The Pacific form (*melanostigma* Cuvier & Valenciennes), seems to differ from the Atlantic *Ablennes hians* Cuvier & Valenciennes, in the less compressed form and the angular (not rounded) form of the dark cross-bars. These marks are variable, and probably but one cosmopolitan species of *Ablennes* can be defined at present.

**Family Holocentridae**

4. **Myripristis chryseres** Jordan & Evermann

Color deep red, with faint pink streaks; fins mostly bright golden yellow, with slight red shades; ventrals and pectorals deep red; a black shoulder-blotch, mostly on opercle above, smaller than in *M. murdjan*. Eye very large.

**Family Gempylidae**

5. **Promethichthys solandri** (Cuvier & Valenciennes)

D. XVIII-I, 17 + 2 or I, 18 + 2; A. I, 15 + 2; eye very large; snout 3.17 in head; maxillary to front of pupil. Teeth sharp, unequal, one-rowed in front, largest in upper jaw.

Color, steel-blue marked with black. Stomach and intestines crowded with small white worms.

Not rare in the markets of Honolulu in September.
Family *Bramidae*

6. **Taractes steindachneri** (Döderlein)

Dark steel-gray with greenish pectoral; last rays of caudal dark green; edge of dorsal and anal darker. Scales without ridges, 45; dorsal 33; anal 28; pectoral very long, longer than dorsal lobe, reaching middle of anal; dorsal lobe high, falcate, ¾ head; anal lobe similar; maxillary reaching middle of large eye, which is twice snout and 3.5 in head; caudal deeply forked. A specimen in the Bishop Museum examined.

7. **Eumegistus illustris** Jordan & Jordan

Part of a large example was seen in the market at Honolulu.

8. **Zalanthias kelloggi** (Jordan & Evermann)

This beautiful species is remarkably brilliant in life. Anterior half of body very pale pink, the head dark orange; posterior parts of body bright scarlet, this color extending on membranes of the spinous dorsal; fins mostly yellow. In spirits, the whole body is plain whitish, the red and yellow fading entirely.

With this species should be compared *Zalanthias azumanus* Jordan & Richardson, from Japan (Proc. U. S. Nat. Mus., XXXVII, 470, 1910), as the two are very much alike. This latter species is the *Anthias japonicus* of Döderlein (Fische Japan, I, 19, pl. III, f. 2), the name preoccupied by *Anthias japonicus* Bloch, a species of *Scolopsis*.

9. **Epinephelus lanceolatus** Bloch

One specimen weighing 360 pounds dressed. Teeth even, in very broad bands; no canines; no flexible teeth evident; preopercle almost entire, weakly serrate; supplemental maxillary very small, apparently obsolete, mouth very oblique; maxillary very broad, 3 in head, extending little beyond the small eye; pectoral short, broad; caudal rounded, fan-shaped. Color dirty olive; sides of head uniform dark brown; fins dark. Scales (pores) 80; dorsal XI, 16; anal III, 9. Dorsal deeply notched, the two parts not separated, the spines rather high.
Sold at auction at 40 cents a pound. Chinese very fond of it, but haole (foreigners) do not like it. It is sold for $1.50 per pound when sliced.

But one specimen of this enormous fish was seen. Its inordinate value and the haste of the fishermen who cut it into steaks, made careful description impossible. Of the known species it seems nearest to *Epinephelus lanceolatus* Bloch, but it is very likely new to science.

**Family Nomeidæ**

10. *Cubiceps thompsoni* Fowler

Very unlike *Ariomma*, certainly not of the same genus. The type in the Bishop Museum is a specimen 1.5 feet long, bluish with large firm scales.

**Family Carangidæ**

11. *Megalaspis cordyla* (Linnaeus)

A single specimen in the Bishop Museum.

Finlets 5; tail short; eye very large; depth 1.25 in head; caudal equal to snout; eye 2 in snout. Body pale greenish or bluish and white, no red; a black opercular spot. Not previously recorded from Hawaii.

12. *Decapterus canonoides* Jenkins

Head 4.1 in length; depth 5.1; dorsal rays $36 + 2$.

Body elongate; no visible teeth in jaws; teeth very faint on vomer and tongue. Soft dorsal black at tip; opercular spot plain; very faint dark shade on side.

This species is common in the Honolulu market and seems valid.

13. *Caranx stellatus* Quoy & Gaimard

Eye golden; teeth in one large row in jaws; small teeth on vomer, palatines and tongue; golden shades on back; pectoral, lower side of head, back and sides, irregularly freckled with small sky-blue and black on brassy background; no silvery;
small sky-blue spots everywhere on back; golden about eye, with sky-blue shades before and below it; dorsal lobe dark, the whole fin shaded with sky-blue, axil dark within, no opercular spot; lower fins all black; a blotch of dark dots above base of pectoral.

Dorsal lobe 1.5 in head; eye 2 in snout, which is 3 in head, 2.5 in depth of body; head 3.5 in length; depth 3; gillrakers moderate, about 30; snout rather long, slightly depressed before eye. D. 24; A. 23. Length 2 feet. This fish is common in the markets of Honolulu and is known as Mukomimi. It is near *Caranx melampygus*, the common Ulua, but is known by the blue-golden coloration. The synonymy of this and some related species is uncertain.


Head 3.3 in length of body; depth 2.83; eye 4.5 in head, 1.5 in preorbital. Dorsal VII-I, 21; anal I, 17; scutes 26; breast scaly, with a small naked patch just before ventral; teeth as in *Caranx melampygus*, no differentiated canines. Body a little more elongate than in *Caranx melampygus*. Preorbital broad, half wider than in *Caranx elacate*; dorsal lobe bluntish, a shade more than half head, equal to preorbital; anal lobe similar; pectoral falcate, very long, 2.75 in length of body, ventrals short; maxillary half head, reaching posterior part of pupil. Color of body and fins all black, as are the lateral scutes; no opercular spot; scutes strong; gillrakers 2 + 10, long and strong.

Two specimens were seen in the Honolulu market, the larger weighing about 12 pounds. The species was first taken in American waters by Lieut. Henry E. Nichols, U. S. N., in 1880, at Sulphur Bay, Clarion Island, Revillagigedo Group, and the specimen obtained (now No. 28,385, U. S. Nat. Mus.) was described by Jordan and Gilbert (Proc. U. S. Nat. Mus., IV, 1881 [1882], p. 227), as *Caranx lugubris* of Poey, a related Atlantic species. This specimen we now designate as the type of *Caranx tenebrosus*. 
Genus *Uraspis* Bleeker

*Uraspis* Bleeker, Amboina, VI, 418, 1855

*Type*: *Uraspis carangoides* Bleeker = *Caranx uraspis* Günther.

Body oblong; teeth in each jaw small and even, in one or two series, none on vomer, palatines and tongue; palate and tongue covered with thick membrane, the tongue and some space around it abruptly white in all species examined, the color contrasting sharply with the blue-black of most of the rest of the mouth; soft dorsal and anal fins without distinct anterior lobe, the number of fin-rays greater than usual in *Caranx*, none of the rays produced; spinous dorsal small; detached anal spines very short, hidden under the skin in adult; adipose eyelids rudimentary; breast naked; lateral line with a long rather low arch; scutes rather small, each with a blunt keel present along whole length of straight portion of lateral line, *its blunt tip turned forward*, not backward as in *Carangidae* generally. General color of body more or less dusky, with or without dark cross-bars.

This genus is especially characterized by the forward direction of the blunt spine on the anterior end of each of the lateral scutes, a character unique in *Carangidae*, and, as in *Leucoglossa*, by the bright white color of the tongue which contrasts sharply with the deep blue-black coloration around it, and by the absence of the usual lobe at the front of the dorsal and anal.

Besides the type species, *Uraspis carangoides* Bleeker (*Caranx uraspis* Günther) of southern Japan and the East Indies, and *Uraspis helvola* of the Society Islands and Hawaii, a new species occurs in Hawaii and another in the Ryukyu Islands and southern Japan.

**Analysis of Species of Uraspis**

a. Teeth in two rows; pectoral short, rounded, not at all falcate; ventrals long, nearly as long as head, reaching anal; keels of scutes prominent, plate-like. Color dark; body with black cross-bars, which sometimes fade in spirits; ventrals black.
b. Body oblong, the depth 2.5 in length; dorsal fin relatively high, the highest ray 1.5 in head; maxillary reaching center of eye; first and last dorsal spines very short, the tips visible; eye about 4 in head; scutes 32; 6 vertical black bars distinctly extending across soft dorsal, three of them across anal; tip of the fins white..........................carangoides

bb. Body relatively deep, the depth 2.2 in length; highest dorsal ray 2.2 in head; maxillary reaching anterior margin of pupil; eye 4.25 in head; scutes 26; vertical bars 7 or 8 in number, faint or sometimes obsolete, not extending on soft dorsal and anal; tips of fins not white; ventrals filamentous, 1.2 in head ..................reversa, sp. nov.

aa. Teeth in one row; pectorals short, but moderately falcate; ventrals pale, short, not reaching midway to anal; soft dorsal moderate; lobes of caudal rather sharp; scutes 36 or 37. Body without dark cross-bars.

c. Body oblong, the depth less than ½ of body. Color not black but yellowish-gray with pearly luster; caudal dark, dorsal with dark edge........helvola

cc. Body rather deep, the depth more than half body. Color very dark with no yellowish shades; dark cross-bands; ventral black......riukiuensis, sp. nov.

15. **Uraspis carangoides** Bleeker

*(Caranx uraspis* Günther)*

This species occurs in southern Japan and the East Indies.

16. **Uraspis reversa** Jordan, Evermann & Wakiya, new species

Plate 22, fig. 1

Body relatively deep; depth 2.5; head 3.4; eye 4.3; maxillary 2.6; pectoral = head, ventral 1.75; depth of caudal peduncle = eye; caudal lobes 1.4 in head; base of first dorsal 3, of second dorsal 2, in length to base of caudal; first and second dorsal rays longest, 2 in head; last rays 2.5 in first; first anal rays = first dorsal rays, the last = last dorsal; pectoral fin rather long, falcate; lateral line with low arch covering anterior half, the posterior half straight, with 26 scutes, the blunt spine of each turned forward, not backward as in the *Carangidae* generally. General color of body more or less dusky, with dark cross-bars.
This species is not rare in Hawaii. Two specimens were obtained.

Type: No. 307, Mus. Calif. Acad. Sci., a specimen 6 inches long obtained in October, 1925, by Jordan and Evermann, in the market at Honolulu.

17. Uraspis helvola (Forster)

Probably originally described from the Society Islands. Once recorded from Japan by Dr. M. Oshima.

18. Uraspis riukiuensis Wakiya, new species


D. VIII-I, 29: A. I-I, 22; scutes 36; head 3.44 in length; depth 2.36; eye 4.7 in head. Teeth on each jaw in a single row; maxillary extending to anterior margin of pupil; gillrakers on lower limb of gill-arch 13, longest one 2.17 in eye. Keel on scutes prominent, plate-like, ending in a spine directed forward at anterior end. First and last dorsal spines very short, but the tips visible; pectorals slightly shorter than head, slightly falcate; ventral blackish, 1.45 in head, 1.4 in distance between its insertion and origin of anal; caudal lobes equal to length of head. Color blackish, not crossed by vertical bands, no yellow tinge, no pearly luster when fresh.

This is the species described and figured from the Riukiu Islands as Caranx (Uraspis) micropterus Rüppell by Wakiya, but it cannot be Rüppell’s species, as shown in the original description and figure given by Rüppell, it has the body no deeper than in helvola. The species occurs about the Riukiu Islands, Japan, and in the Province of Kii, Japan.

Type: No. 7747, Carnegie Museum, a specimen 210 mm. long, from Kii, Japan.

There is little doubt that Caranx micropterus Rüppell is a synonym of Caranx helvolus Forster, for the original description and figure given by Rüppell of the former species quite agree with the description given by Günther of the type of the
latter. *Caranx helvolus* of Jordan and Evermann, Fishes of Hawaii, is different. The type locality of *helvolus* is most likely some part of the Indo-Pacific region, probably Tahiti, as Forster made his principal collection in the Society Islands.

**Leucoglossa** Jordan & Evermann, new genus

*Type:* *Leucoglossa candens* Jordan, Evermann & Wakiya, new species.

(*Carangus helvolus* Jordan, Evermann & Wakiya; not *Scomber helvolus* Forster)

This genus has the general characteristics of *Uraspis* except that the blunt spines on the lateral scutes are normally placed, they being directed backwards as in all other *Carangidae*. In *Leucoglossa* the pectoral fins are long and falcate, not shorter than head; the ventral fins are pale, short, not reaching halfway to anal; caudal lobes long. Color blackish, without dark cross-bars. In each of the two known species the inside of the mouth is blue-black, the tongue and the region about it being abruptly clear white, as in *Uraspis*.

**Analysis of Species of Leucoglossa**

*a.* Body oblong, its depth not \( \frac{3}{5} \) its length; keel on scutes distinct but scarcely developed into a plate, ending in a blunt spine at posterior end....................*candens*, sp. nov.

*aa.* Body rather deep, its depth more than \( \frac{3}{5} \) its length; keel on scutes each developed into a plate with a blunt spine posteriorly.........................*albilinguis*, sp. nov.

19. **Leucoglossa candens** Jordan, Evermann & Wakiya, new species

*Carangus helvolus*, Snyder, Bull. U. S. Fish Comm., XXII, for 1902 (Jan. 19, 1904), p. 524; Jordan & Evermann, ibid., XXIII, pt. 1, for 1903 (1905), 196, pl. 32; not of Forster.

D. VIII-I, 28; A. I, 28; scutes 33; head 3.27 in length; depth 2.45; eye large, 4.2 in head. Teeth on each jaw in a single row; maxillary extending little beyond anterior margin of pupil; gillrakers 4 + 15, longest 2 in eye; keel on scutes
distinct, but not developed into a plate, ending in a spine at posterior end; dorsal spines apparently very short, but the tips visible, highest one 2.33 in soft dorsal, which is 2.54 in head; pectorals longer than head, falcate, reaching above sixth anal ray; ventrals whitish, 2.34 in head, not reaching midway between their insertion and origin of anal; caudal lobes rather shorter than head. Body black, not crossed by vertical bands; no yellowish tinge, no pearly luster.

The above description is based on a specimen from Honolulu measuring 268 mm. in length of body. Jordan and Evermann give an excellent plate under the erroneous name of *Carangus helvolus*. The form of body of this species is much like that of *Uraspis helvola*, but the body is black and not tinged with yellow.

We take as type of this species the specimen identified by Professor John O. Snyder as *Carangus helvolus* (Forster), and which is now in the U. S. National Museum at Washington where it bears the number 55,170.

The species is common in the Honolulu markets, especially in the autumn.

20. **Leucoglossa albilinguis** Jordan, Evermann & Wakiya, new species

   Plate 22, fig. 2

D. VI-I, 27; A. I, 21; scutes 36; head 3.52 in length; depth 2.33; eye 4.75 in head. Teeth on each jaw in a single series; maxillary extending a little beyond anterior margin of pupil; gillrakers on lower limb 15, longest one 1.45 in eye; keel on scutes prominent, plate-like, its spines turned backward. Highest dorsal spine 2.9 in soft dorsal the highest ray of which is 2.17 in head; pectorals longer than head, falcate; ventral short, whitish, 2.17 in head, scarcely reaching midway of distance between its insertion and origin of anal; caudal lobes as long as head.

Color of body black, no cross-bars, no yellow tinge, no pearly luster when fresh.
This species resembles *U. riukiuensis*, but may be distinguished by having the ventrals shorter and paler, the pectorals longer, the gillrakers longer, the soft dorsal lower, and especially in having the plate-like keel of scutes not ending in a spine at anterior end.

*Type:* No. 305, Mus. Calif. Acad. Sci., a specimen 11 inches long, collected by Jordan and Wakiya in October, 1925, in the market at Honolulu.

**Ferdauia** Jordan, Evermann & Wakiya, new genus

*Type:* *Carangoides jordani* Nichols.

This new genus differs from *Carangoides* Bleeker, in the naked breast. It includes *Caranx orthogrammus* Jordan & Gilbert (1881), and the following two species.

21. **Ferdauia evermanni** (Nichols)

Plate 22, fig. 3

*Carangoides gymnostethoides evermanni* Nichols, American Museum Novitates, No. 3, p. 2, fig. 1 (type and cotype), March 9, 1921, collected August 25, 1920, by B. W. Evermann in the market at Honolulu.

This species is not uncommon in the markets at Honolulu.

22. **Ferdauia jordani** (Nichols)


This species is, with *F. evermanni*, not uncommon in the Honolulu markets where several specimens of each were examined by the present writers in September and October, 1925.
Family Priacanthidæ

23. Priacanthus ulalaua Jordan & Evermann

Not rare in the Honolulu markets where the writers examined specimens in September and October, 1925.

24. Priacanthus meeki Jenkins

Plate 23, fig. 1

Head 3.21 in length; depth 2.70; eye 2.37 in head; interorbital (between bones) 4.22; snout 3.17; maxillary 1.9; depth of caudal peduncle 3.8. D. X, 14; A. III, 15; P. 19; C. (branched rays) 14; scales 14-120-52.

Body ovate, compressed, the upper and lower outlines evenly curved; caudal peduncle short, narrow, strongly compressed; head shortish, with nearly straight profile to origin of dorsal fin; interorbital space convex transversely, a little wider than one-half eye; snout shortish, very blunt, a little longer than postorbital region; mouth wide, oblique, lower jaw much the longer; teeth small, sharp, in bands in jaws, vomer, and palatines; outer teeth in upper jaw much larger than inner; lower jaw with only two rows of teeth, as large as outer ones of the upper; no interior row; preopercle serrated behind and below, its angle obtuse, ending in a large blunt spine; opercle, subopercle and interopercle with entire margins; opercle with two short flat spines, the lower much the larger; pseudobranchiae well developed; gillrakers 2 + 24, lanceolate, the longest about half eye; dorsal originating over base of pectoral, its spines subequal, eighth longest, 1.9 in head, soft part shorter than the spinous, with angular free margin; anal inserted below seventh dorsal spine; third spine stouter and longer than second, 1.81 in head; soft part similar to soft dorsal, each reaching base of caudal when depressed; pectoral low, shortish, about half head length, with rather acute posterior tip, not falcate, reaching anal; ventral slightly before pectoral, long, reaching beyond base of third anal spine; vent directly in front of anal; caudal slightly emarginate; scales small, strongly ctenoid; head closely scaled, including maxillary, throat and dentary; lips and branchiostegal membranes naked; lateral line rising abruptly for 10 pores from gill-opening, thence concurrent
with back to caudal peduncle, along the middle of which it follows to base of caudal. Color in life, blood-red, deeper red than in *P. alalaua*, or *P. corinus* (*cruentatus*) with no dark cross-bars or rosy spots; about 15 very faint round dusky spots along lateral line plain deep red, dorsal and anal dark-edged; caudal mesially dark-edged; ventral rays dark; pectoral rosy; inside of mouth deep orange-red; no yellow anywhere. Color in spirits, uniform dark brown; dorsal and anal black, the spines and rays whitish; ventral and caudal blackish, much lighter proximally; pectoral yellowish.

The specimen here figured seems to belong to *Priacanthus meeki* Jenkins, though the scales seem slightly larger, the gill-rakers fewer. The coloration of the body seems substantially the same. The species is rare about Honolulu and may be known by its small scales and deep red color, being almost black in spirits.

25. *Priacanthus helvolus* Jordan, Evermann & Tanaka, new species

Plate 23, fig. 2

Head 3.50 in length; depth 2.60; eye 3 in head; snout 3, maxillary 2; least depth of caudal peduncle 3 in head; D. X, 14; A. III, 14; P. 17; C. 17; scales 12-103-40.

Body moderately elongate, the outline evenly curved. Head moderate, eye very large; snout short and blunt, about equal to postorbital region; mouth wide, oblique, the lower jaw longer; teeth small, two-rowed, those of the outer series longer; preopercle nearly entire, with a short, blunt spine at angle; opercular spines obsolete. Gill-structures usual.

Dorsal spines subequal, progressively longer backward, the last longest, 1.9 in head; soft anal similar to soft dorsal, the longest ray about half head; third anal spine 1.85 in head; dorsal and anal not reaching caudal when depressed; pectoral short, half length of head, slightly acute at tip, about reaching anal; ventrals long, reaching third anal spine; caudal slightly lunate. Lateral line as usual; head scaly everywhere except on lips. Coloration in life, pale bronze or yellowish, with no dis-
tinct red, the body nearly white, with irregular blotches of bronze on sides; head dark bronze, suborbital silvery; dorsal fin black, the spines pinkish; spinous dorsal and anal with small obscure blackish spots towards the back; caudal mostly black, the base pinkish; basal area of pectoral copper red; ventral dusky, the membrane dark green, the spines pinkish. In spirits, the body color is plain, dirty, yellowish white, the fins dusky, especially at tip.

This fish is near *Priacanthus meeki*, but is totally different in color, with more elongate body and rather larger scales.

The species is known from one example.

*Type:* A specimen 215 mm. long, No. 345, Mus. Calif. Acad. Sci., obtained by Jordan and Evermann in October, 1925, in the market at Honolulu.

**Family Etelidae**

The group here called *Etelidae* differs from the *Lutianidae* in having the dorsal and anal fins entirely free from scales. A few of them (*Apsilus* and *Tropidinius*), have the occipital ridge extending forward over the top of the cranium, as in *Lutianus*. Most of them, however, have the cranium nearly flat, with a distinct line of demarkation shutting off the occipital crest from top of head.

Those genera with the dorsal deeply notched, the allies of *Etelis*, are well defined, as are also *Apsilus* and *Aprion*, which have short pectorals. The other genera or subgenera are all closely related and might be all regarded as subgenera of *Pristipomoides*, as the differences are mainly matters of degree. Of the minor groups, *Rooseveltia* and *Pristipomoides* are fairly defined. The others, *Bowersia*, *Ulaula*, and *Arnillo* might well be regarded as subgenera of *Platyinius*. In this paper, however, we prefer to regard them all as distinct genera.

We here present an analysis of the genera (or subgenera) of *Etelinae* and *Verilinae*. The characters of the *Etelinae* proper (*Etelinus*, *Etelis* and *Etelides*, with the related genus *Verilus*), have been well given by Jordan & Jordan (Mem. Carnegie Mus., X, no. 1, December 1927, p. 50).
The Etelinæ are all shore fishes of the tropics; *Apsilus* at the Cape Verde Islands, while *Tropidinius* and *Platyinius* are confined to the West Indies. *Etelis* is cosmopolitan. The others inhabit the East Indies and the South Seas.

**Analysis of Genera of Etelinæ and Verilinæ**

*a.* *Etelina.* Cranium solid; skeleton firm; dorsals more or less fully connected; soft dorsal and anal scaleless; last ray of dorsal and anal each produced; canines usually present, but never large; scales above lateral line parallel with it; dorsal spines 10; anal spines 3.

*b.* Dorsal fins with the margin continuous, not deeply notched; coloration mostly olive.

c. Pectoral very short, rounded, much shorter than head; tongue with small asperities at base; teeth small, the outer slightly enlarged, not canine-like; preopercle entire; coloration plain.

d. Head rounded above as in *Lutianus*, the occipital crest not extended forward on the cranium; pectoral 1.5 in head; caudal lobes pointed, slightly longer than head; scales 65 (*fuscus*)...*Apsilus* Cuv. & Val.

*dd.* Head flattened above, the occipital crest encroaching on top of cranium; pectoral about half head; caudal lobes pointed, not longer than head; scales about 50 (*virescens*)...*Aprion* Cuv. & Val.

c. Pectoral long, falcate or lanceolate, little if any shorter than head; coloration nearly plain olivaceous, except in *Roosevellia*, *Arnillo* and *Pristipomoides*.

c. Nape keeled, the occipital crest encroaching on interorbital area; canines small, no teeth on tongue; pectoral as long as head, reaching anal; gillrakers 5 + 17; preopercle serrulate; scales 60 (*dentatus*)...*Tropidinius* Gill

c. Nape not keeled, occipital crest not encroaching on interorbital area.

*f.* Caudal lobes moderate, subequal, neither of them produced in a filament.

g. Skull thick, with three blunt ridges above separated by narrow grooves; gillrakers few, 4 + 11; canines rather strong; no teeth on tongue; preopercle evidently serrulate; color golden and scarlet (*brighami? = zonata*)...*Roosevellia* Jordan & Evermann

*gg.* Skull flat above or gently convex, without notable ridges; gillrakers more than 12 below arch; depth 3.5 in length.
h. Tongue with a broad patch of teeth; scales 70; gillrakers 4 + 15; color violaceous olive (violescens). . . . Bowersia Jordan & Evermann

hh. Tongue without teeth or with a few asperities at base.

i. Anterior teeth in both jaws, small but canine-like.

j. Body rather deep, depth about 3 in length; pectoral as long as head, reaching front of anal; gillrakers 5 + 15; preopercle serrulate; scales 60. Color nearly plain, light blue and olive. (vorax = macrophthalmus) . . . . Platyinius Gill

jj. Body slender, the depth 3.75 in length; pectoral shorter, not reaching vent; gillrakers 5 + 19; scales 70. Color plain blue and gold, a large bright yellow blotch on upper lobe of caudal (auricilla)

Arnillo Jordan, Evermann & Tanaka, new genus

ii. Anterior teeth very small, not canine-like; pectoral as long as head; gillrakers 5 + 21; scales 68; body slender, depth 3.8 in length; color silvery, nearly plain (ulaula = sieboldi).

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Genus *Arnillo* Jordan, Evermann & Tanaka, new genus

*Type:* *Arnillo auricilla* Jordan, Evermann & Tanaka, new species.

This genus or subgenus is related to *Bowersia*, differing in minor matters, especially in the absence of teeth on the tongue, these being only minute asperities; the gillrakers are more numerous, 10 + 19, instead of 5 + 14. From *Pristipomoides*, *Arnillo* with *Platyinius* and *Bowersia*, differs in the moderate caudal, neither lobe being produced. The coloration in the type of *Arnillo* is unique in this group. *Arnillo* is the local name in Cuba for *Tropidinius dentatus*.

26. *Arnillo auricilla* Jordan, Evermann & Tanaka, new species

Plate 23, fig. 3

Head 3.5 in length without caudal; depth 3.86; eye 3.71 in head; interorbital between bones 3.55; snout 3.25; depth of caudal peduncle 3.55; maxillary 2.6, its breadth at distal extremity 9.75; preorbital width 6.0; Br. 7; D. X, 11; A. II. 8; P. 16; C. (branched rays) 15; scales 8-70-18.

Body long, compressed, upper and lower outlines equally and evenly curved; caudal peduncle longish, its length 1.73 in head, rather slender, compressed. Head large, stoutish, bluntly conic, its profile nearly straight, with a slight depression over eye; eye large, lateral, high up, with a slightly developed adipose lid; interorbital broad, slightly and evenly convex, separated from occipital region by a transverse groove on which median and lateral crests are procurrent; frontal region not narrowed forward; nostrils subequal in size, irregularly circular in shape, close together, much nearer front margin of eye than tip of snout; anterior nostril with well developed posterior flap, the posterior without a flap; snout short, stoutish, with evenly curved profile; maxillary extending midway between anterior margin of pupil and center of eye; preorbital
rather wide, its width 1.62 in eye diameter; mouth large, slightly oblique, lower jaw much the longer; upper jaw with inner band of viliform teeth and a single row of much larger, almost canine-like teeth which are set rather sparsely; lower jaw with similar dentition as in the upper tip, but laterally with only one row of subequal small canines, smaller in size than the corresponding teeth in the upper, and set more closely; vomer and palatines toothed; tongue broadly rounded, free anteriorly and laterally, with a patch of very weak asperities at base; preopercle serrulate behind and below, broadly rounded at angle, above which it has a very shallow notch almost indiscernible; opercle with three flattish points of which the upper two are short and very close together. Gill-openings large, continued forward below, the membranes separate, free from the isthmus; gills 4, a large slit behind the last; pseudobranchiae well developed; gillrakers on first gill-arch long, lanceolate, 10 + 19 in number, the longest 2.33 in eye diameter. Dorsal inserted over end of first fifth of pectoral, fourth and fifth spines longest, 2.36 in head, last ray slightly produced; anal inserted below third ray of dorsal, third spine longer and stouter than second, its soft part similar in form to soft dorsal; pectoral long, falcate, scarcely reaching vent; ventral inserted slightly behind base of pectoral, reaching a little farther back than pectoral; caudal deeply forked, its lobes subequal. Scales ciliated; cheek with seven rows of scales, opercle with about 12 rows; a small patch of scales in four rows on side of top of head directly in front of transverse groove near occiput; lateral line high, complete, concurrent with back; no scales at base of dorsal or at base of anal.

General color in life, pale gold and gray blue, intermixed over body in fine pattern, the blue forming short diffuse cross-bars on side; golden streaks extending on head; dorsal and pectoral light yellow; anal white; upper lobe of caudal vivid clear yellow, bordered all around with bluish gray; lower lobe gray; a bright, light blue spot at base of each dorsal ray. Color in alcohol, brownish, a little lighter; very faint, irregular blotches visible in places; dorsal dusky; pectoral light; anal and ventral light dusky, first ray of latter fin much darker; caudal dark dusky, the upper lobe mostly yellow, bordered by dark dusky above and beneath.
The species is allied to *Rooseveltia brighami* (Seale) and to *Bowersia violescens* Jordan & Evermann, from each of which it differs in having a more slender body, wider interorbital, and especially in the coloration of body and caudal fin. It is a very beautiful fish, as is also *Rooseveltia zonata*, but the coloration is wholly different. Three examples seen in the Honolulu market.

According to Fowler, *Rooseveltia zonata* (Cuv. & Val.), is identical with *Rooseveltia brighami* from Hawaii, but neither species can be referred to the genus *Apsilus* which is well marked by its short pectoral and keeled nuchal region.

*aurum*, gold; *cilla*, tail.

**Type:** No. 348, Mus. Calif. Acad. Sci., a specimen 320 mm. long, obtained by Jordan and Evermann in October, 1925, in the market at Honolulu.

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**Family Aphareidæ**

**Aphareus** Cuvier & Valenciennes

The three known species referred to *Aphareus* were all found in the markets of Honolulu on the same day in October, 1925. Each of the three may be regarded as the type of a distinct subgenus. They may be compared as follows:

a. Gillrakers about 21 (5 + 16); caudal fin moderately forked, shorter than head; last ray of dorsal and of anal about twice length of others; 10 dorsal spines.

b. *Sacrestinus*. Body relatively deep, the depth 3 to 3.3 in body, third dorsal spine highest, about 3 in depth of body; pectoral fin moderate, 1.2 in head, the lower lobe obsolete or nearly so.

c. Head 3.3 in length; eye large, 4.5 in head; snout about 3; preopercle, suborbital and suprascapular finely but distinctly striated; mouth moderate, maxillary reaching front of pupil, 1.9 in head; scales 72. Color, dark gray-blue, darker than the other species; head with more or less yellow; caudal fin yellow, tipped with red.

Size small .................................................. *flavivultus*

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1 Sacrestin (Sacré Chien), a local name of *Aphareus furcatus*, on the Ile de France.
bb. Aphareus. Body relatively elongate, the depth 3.75; third, fourth, and fifth dorsal spines subequal, about 3 in depth of body; pectoral long, 1.2 in head, lower lobe well developed; caudal lobes long, 1.2 in head; head long, 3.3 in length; snout long, 2.4 in head; eye small, 5.5; mouth large, maxillary 1.7 in head, reaching posterior border of pupil; preopercle, suborbital, and suprascapula very finely striated or almost smooth; scales 72 to 75. General color, blue-gray; caudal with scarcely any red, blackish, with a broad pink edge. Size small, reaching little more than a pound.................furcatus

aa. Fares. Gillrakers about 50 (16 + 34); caudal fin very deeply forked, the lobes in adult longer than head; pectoral fin in adult longer than head, its lower lobe well developed; head 3.5; scales 75. Color gray, suffused with pink; fins rosy; a yellow spot on membrane at base of each dorsal ray; weight 20 lbs...............rutilans

27. Aphareus (Sacrestinus) flavivultus (Jenkins)

Aphareus flavivultus Jenkins, Bull. U. S. Fish Comm., XIX, 1899 (June 9, 1901), 300, fig. 4, Honolulu. (Example with the whole top of head yellow.)


Abundant in the markets of Honolulu in October. Two examples each about 320 mm. long were retained. Snout shortish, blackish, 3 in head; maxillary reaching center of eye; head short, 3.5 in length, the depth 3.2; mouth rather small, the maxillary 2.5 in head; scales 80, gillrakers 5 + 17 = 22; caudal lobes 3.8 in length; third dorsal spine highest.

Color in life, gray-blue with no red or pinkish shades on body; head shaded with golden brown on snout, preopercle and axil; top of head sometimes entirely golden-brown (as in Jenkins's original type); some faint golden shades on sides; dorsal pale yellowish green, with red tips and some blackish on edge of membranes, this shading into red posteriorly; caudal dull yellow, the narrow posterior margin bright red; upper and lower rays marked with red; anal golden, tipped with red; pectorals and ventrals golden with red shading;

^ An Arabic name of Aphareus rutilans.
maxillary gold-shaded; top of head with a shade of golden brown.

This species differs from *Aphareus furcatus* (Lacépède) in the much deeper body and in the dominant color of blue-gray, with considerable red and yellow on the head and fins, and especially in having the third dorsal spine higher than the fourth or fifth. The mouth is smaller, the snout shorter and the short pectoral without a distinct lower lobe. It is well figured by Jenkins, Bull. U. S. Fish Comm., XIX, 1899 (June 8, 1901), 391, fig. 4. The same figure is copied by Jordan and Evermann, op. cit., XXIII, 1903 (1905), p. 235, fig. 96.

28. *Aphareus furcatus* (Lacépède)


*Caranxomorus sacrestinus* Lacépède, op. cit., V, 682, 1803, from a description by Commerson of the species already named *furcatus* from his drawing.

*Aphareus carulescens* Cuvier & Valenciennes, Hist. Nat. Poiss., VI, 487, 1830, Île de France (name a substitute for *furcatus* and *sacrestinus*).

Color, lustrous gray-blue in life, silvery below; a slight golden wash on sides medially; no red, nor clear yellow anywhere; dorsal fin all blackish, the posterior edge slightly red; caudal blackish with a broad pink edge behind; anal yellowish, reddish on tips; pectoral pinkish; ventral gray with a little pinkish.

This species, like the others of this family, has soft flesh of good flavor. It is readily distinguished from the two others found with it in Hawaii by the form of the dorsal fin, in which the third ray is not elevated above the fourth, and the pectoral is as long as the head and with a distinct lower lobe. The
slender body, larger mouth, longer head and the coloration readily distinguish it. It is dull in color without bright red or yellow. Dorsal X, 11, as in all the species of the group.

**Fares** Jordan, Evermann & Tanaka, new subgenus

*Type:* *Aphareus thompsoni* Fowler = *Aphareus rutilans* Cuv. & Val.

This subgenus is closely allied to *Aphareus* but has the gillrakers very long, about 51 in number (17 + 34), and the caudal fin longer than head and very deeply forked; last ray of dorsal and anal prolonged in a filament and more than twice length of other rays; pectoral fin with a strong lower lobe. *Fares* is the Arabic name of "*Aphareus rutilans,*" which suggested to Cuvier the name *Aphareus,* an unidentified Greek name of some fish.

29. *Aphareus* (*Fares*) *rutilans* (Cuvier & Valenciennes)

Plate 24, fig. 1


Two specimens examined respectively 630 and 800 mm. long. Nine others were seen in the Honolulu market; the largest weighed 20 pounds.

Teeth minute, rasp-like in front of lower jaw and along upper, none on vomer or palatines; pseudobranchiae very large; gillrakers very long, 16 or 17 + 32 to 35 = 48 to 52; third, fourth and fifth dorsal spine highest, subequal. Pectoral falcate, about as long as head, with a distinct lower lobe; ventral long; caudal lobes very long, 3 to 3.75 in body, nearly as long as head, longer than the head in large examples, 3.5 in length; scales 73. Dorsal X, 11, the first spine very short.

Color in life, dull pink above, silvery below; top of head clear brownish red; lower jaw silvery purplish; fins brick red;
whole edge of dorsal besides its base, bright yellow, its base with bright yellow spots on the membranes; anal pink, the long filament deeper red; ventral pink, tip white; caudal red, varying to yellowish.

In alcohol, the red colors fade and the body and fins become dusky brown.

This species reaches a much larger size than either of the two others. It is not uncommon in the markets of Honolulu in October, and is valued as food. In all the species the flesh is soft, but of good flavor.

The plate of *Aphareus rutilans* given by Bleeker, later identified as *A. furcatus* by the same author, certainly represents this species rather than *A. furcatus*, and Cuvier’s account of *Aphareus rutilans* accords better with this which is gray-red in life rather than gray-blue.

**Family Mullidæ**

30. *Upeneoides arge* Jordan & Evermann
   Weke pahala or Crazy Surmullet

Hon. John M. Wilson, Mayor of Honolulu, reports that eating the head of this fish produces a sort of delirium ("Loco"). At one time in Molokai 30 or 40 Japanese laborers working for Mr. Wilson ate the heads (with bodies) of many examples and were mentally paralyzed at the time. Mrs. Wilson once attended a function at which this fish was served. All members of the party had weird visions, some of them wandering about the house all night long. It was agreed that “somebody must have died in that room”,—a Hawaiian superstition. It is agreed that the poison lies in the brain. A fresh example was turned over in November to Dr. Nils Larsen, director of the Queen’s Hospital. He fed the brain to a cat, which at once went crazy, but recovered, as in fact, all cases soon recovered. Dr. Larsen fed other species and the flesh of *U. arge* to cats but with no result. In the winter he fed the brain of this species to cats and they were not affected.
Family Chaetodontidae

31. Chaetodontoplus arcuatus (Gray)

All markings black, with clear white around the black; back brownish, with pale spots.

Very rare; it has not been seen for many years. It is well figured by Günther.

Family Labridae

32. Lepidaplois macrourus (Lacépède)

There is in the Bishop Museum a cast of a specimen of this species from Laysan Island. It is 1.5 feet long. Top of head with 4 blackish violet stripes on each side, red between; sides of head gray, with small round red spots; a dark shade backward from mouth; whole back deep scarlet red, un-striped; black patches under last dorsal rays large; preopercular limb broadly naked, except for two scales; ventrals falcate, reaching nearly to anal, edged with pale within the gray-blue, yellow on membranes, scarlet on spines, outer rays light blue; base of spinous dorsal blackish on membranes all the way; soft rays scarlet orange. Scales 31.

Family Scaridae

33. Scaridea zonarcha Jenkins

Body gray, with some scales white, some black, some dull yellow; 3 orange-brownish bands on chin, alternating with white; head speckled and spotted with whitish; caudal dusky behind, with slight pale edge; outer rays barred with dark, inner profusely speckled with white; fins much mottled; pectoral light yellow; scales much and irregularly spotted; anal yellowish, much mottled. Not rare in the markets of Honolulu; several specimens obtained.
34. Scarus leucostigma Jordan, Evermann & Tanaka, new species

Plate 24, fig. 2

Head 3 in length without caudal; depth 2.66; eye 7.13 in head; interorbital 2.56; snout 2.34; preorbital 3.57; D. IX, 10; A. III, 9; P. 15; C. (branched rays) 11; scales 2-23-6.

Body deep, compressed; dorsal profile evenly convex from tip of snout to base of caudal peduncle which is deep and strongly compressed; ventral outline nearly similar to the dorsal; head large, heavy, deep and compressed; eyes high up, lateral; interorbital broad, strongly convex; snout long, very blunt; mouth small, in axis of body; jaws subequal, the lower slightly included; teeth whitish, yellowish at base; posterior canine not developed; upper lip double only posteriorly, covering only about half the dental plate; cheek with two rows of scales, seven scales in the upper and only one in the lower row; no scales on lower limb of preopercle; posterior limb of opercle with two rows of large scales; anterior limb with a single series; opercle with a short broad flap; five scales on median line in front of dorsal; spines subequal, soft rays slightly elevated posteriorly, the longest 2.34 in head; anal similar to soft dorsal; pectoral rather long, not quite reaching origin of anal, its upper longest rays 1.46 in head; posterior margin oblique, very broadly rounded; ventrals inserted below base of pectoral, shorter than the latter fin, reaching short of vent by about one-half its length; caudal very broad, subtruncate, its outer rays 1.58 in head. Scales large and thin, closely covered with granulations except on the margin; a row of modified scales at base of dorsal and anal; last scale of lateral line very broad and large, more than half width of caudal peduncle and much the largest of all the scales; lateral line following curvature of back to the tenth row of scales except one under the last ray, then dropping down two rows and continuing on middle of caudal peduncle to base of caudal, 18 pores in the upper row and 7 in lower.

Color in life, deep red brown, a little clearer below; fins all dark red, dorsal and caudal narrowly edged with dark blue;
ventral and anal same as pectoral, dull red, front rays bluish; a pale yellowish area across head; before eye an oblong figure, somewhat as in Scarus perspicillatus and Scarus kraussi, but made up of separate bluish white spots, very distinct, not connected, the central figure not divided on median line; an irregular white band across lower jaw; many rounded, sharply-defined, pale spots along side of head below. The other side not quite the same, the white spots on the two sides of head therefore not quite symmetrical, 18 spots on left, 16 on right; an oblong white spot on median line behind chin; jaws pink, white-edged.

Color in alcohol, back dark purplish brown, much lighter below; head similar in color to upper part of body; vertical fins dark purplish brown, with narrow dark margin except caudal which has a dark-blue margin around; pectoral and ventral dusky, the latter fin having darker tip; pale spots and marks as above described.

The species is allied to Scarus miniatus, differing from the latter in having much darker color, and especially in having the caudal fin slightly rounded and in having peculiar markings on head.

**Type:** No. 370, Mus. Calif. Acad. Sci., a specimen 245 mm. long, obtained by Jordan and Evermann, in October, 1925, in the market at Honolulu.

35. **Scarus gilberti** Jenkins

Panuhunuhu

Color pale blue, green-shaded posteriorly; edge of each scale dull brownish red; head brown above; two short green streaks behind eye; cheeks greenish shaded; a bright blue stripe below eye to upper lip where it broadens to cover upper jaw; lower lip blue then broadly brown, then broadly bright blue; a cross-shaped blue figure on each side of throat; breast with 3 bluish shades, then a bright blue median stripe to ventral; ventrals mesially pink, first and last rays bright blue; pectoral with the front rays bright blue; axil black within; sides of belly with faint streaks made of the blue of the scales; dorsal
pinkish, a blue stripe at base and a blue margin; anal creamy pink, with stripes as on the dorsal but brighter and broader; caudal moderately lunate, the middle rays 1.67 in head; middle rays orange with 3 rows of blue spots, the outer forming a margin; mesial part of fin pale orange. Posterior canine present. *Scarus jenkinsi* Jordan & Evermann seems the same as *Scarus gilberti*, but with green shades instead of blue.

36. *Scarus ahula* Jenkins

Panuhunuhu

Very pale, livid purplish, edge of scales brownish; head plain, pale, upper lip nearly covering jaw; no posterior canines. Scales in 2 rows on cheek. Anterior profile very convex; fins all creamy pink, paler at base; caudal slightly concave; body plump; eye small; caudal with slight dusky edge below and behind. Head 3.5; depth 3. This specimen shows no depression above eye, though it agrees otherwise with *Scarus ahula*.

Family Gobiidæ

37. *Chonophorus stamineus* (Eydoux & Souleyet)

Plate 24, fig. 3

Head 2.8 in length without caudal; depth 4; eye 7 in head; interorbital width between bones 10.5; snout 2.53; depth of caudal peduncle 3.51; maxillary 2.1; D. VI-10; P. 15; C. (branched rays) 13; scales 65-25.

Body tad-pole like, oblong, compressed; very large anteriorly; caudal peduncle moderately deep, strongly compressed; dorsal outline evenly and regularly curved from tip of snout to caudal peduncle, ventral outline a little less arched. Head very large, heavy, with gently curved profile; eye high, directed slightly obliquely upward at the middle of length of head; interorbital width between bones very narrow; snout long, 1.11 in postorbital part of head; maxillary extend-
ing to vertical through front of eye, subinferior and sub-horizontal; lips broad, thick, upper one much more so; lower jaw included; teeth in jaws small, acute, in rather wide bands a little narrower laterally; tongue slightly notched at tip; gill-openings large, almost lateral, the membranes joined to the broad isthmus, the width of which is 3.94 in head; shoulder-girdle with two fleshy prominences as usual in Chonophorus; pseudobranchiae present; gillrakers $3 + 6$, short, blunt and with smooth edges. First dorsal with its free margin usually broadly rounded, sometimes concave, fourth spine longest, its length 2.11 in head; second dorsal higher than first, the rays except first two subequal, length of most rays of fin 2.74 in head; anal inserted below fourth soft ray of dorsal, its rays a little shorter, 2.86 in head, neither fin reaching caudal when depressed; pectoral broad, with rather acutely rounded posterior margin, middle rays longest, 1.85 in head, reaching over vent; width of pectoral base 3.5 in head; no silky rays on upper part of pectoral; ventral inserted beneath pectoral, reaching a little beyond middle of pectoral when depressed; caudal rather long; rather acutely rounded, middle rays 1.59 in head; scales moderate in size, cycloid; head entirely naked.

Color in alcohol, as in life, brownish black above, much lighter below; head also brownish black all over except posterior margin of branchiostegal membranes which is distinctly whitish; upper and middle part of body faintly and irregularly mottled, a little more distinctly so along middle of body; all the fins colored like upper part of body except ventral which is light dusky, with whitish margin all around; posterior margin of pectoral and free margin of anal whitish; a diffuse black blotch at base of caudal; no ocelli nor other definite markings; the marks all fainter in large examples, which become uniform dusky.

This species is very abundant in pools of mountain streams and also in irrigation ditches in the island of Oahu. Upwards of a hundred specimens were obtained for us by boys with hook and line in Gray’s pool in Kalihi Stream, some five miles northwest of Honolulu. It is found in great abundance in the broad irrigating ditch supplying the great Ewa plantation near
Pearl Harbor in Oahu. At the time of collecting in Kalihi pool, some thousands of eggs of the Japanese Ayu, *Pleco-glossus alivelis*, were planted by Dr. Chiyometsu Ishikawa, the gobies being removed as likely to endanger the young Ayu.

Family Molidæ

38. *Ranzania makua* Jenkins

Three vertical pale bars on head, unequal, each edged with black; 3 black bands on tail, edged with white. Dorsal and anal pale mesially, edge broadly dark. This species which varies in color with age is probably identical with *Ranzania truncata* Nardo, of Brazil.

1. *Aphareus (Fares) rutilans* (Cuvier & Valenciennes).
In November and December, 1927, Captain G. Allan Hancock, of Los Angeles, made a trip with his SS Oaxaca, to the Galapagos Islands. The writer and Mr. Frank Tose, chief of exhibits of the California Academy of Sciences, were kindly invited by Captain Hancock to accompany the expedition as his guests, representing the Academy.

Brief stops were made at several different places on the way down and back. One of these was at Malpelo Island, a barren basaltic rock, first sighted by Colnett in 1793, and situated, according to the latest surveys, in Lat. 3° 59' N. and Long. 81° 34' W. It lies about 250 miles off the mouth of the San Juan River, United States of Colombia.

Captain Hancock stopped the Oaxaca a short time off this island on which I was able to make a landing from a small skiff on the northeast end, on the morning of December 20. My good friend, Mr. J. T. Boumphrey, also a guest of Captain Hancock, after landing me, stood by with the skiff in case a hurried departure became necessary.

The Hydrographic Office\(^1\) states that some dwarf bushes grow in the cracks and gullies, but a close inspection failed to

---

locate any plant life whatsoever. At a short distance the
island appears light green in color, but this is probably caused
by the guano from the numerous sea birds. As the island is in
a rainy belt and often drenched by heavy squalls, miniature
waterfalls can be seen tumbling down over the face of the
rock. With the exception of the birds seen, a short search
failed to reveal any life whatever, but some small crabs and
two species of lizards, Anolis agassizii Stejneger, of which
27 specimens were collected, and a new species of Celestus of
which 10 specimens were secured.

The island is a mere rock about a mile in length and 846 feet
in height. From a distance it appears like a gigantic castle
projecting out of the ocean.

The following birds were noted: Brewster’s Booby, Blue-
faceted? Booby, two Martins (Progne), and a Spotted Sand-
piper (Actitis macularia).²

The accompanying plates are from photographs by Mr.
George Stone, published with the permission of Captain
Hancock.

Celestus hancocki, new species

Plate 26

Diagnosis: Size large. Snout depressed, sharply rounded;
ear-opening round or somewhat elongated; rostral twice as
broad as high; nasal situated posteriorly in a single plate; two
postnasal plates; supraorbitals five; two large pairs of supra-
asals; azygos prefrontal longer than wide, tapering to a point
posteriorly and touching the frontal; a pair of fronto-parietals;
five pairs of chin shields, first three in contact with lower
labials; 10 upper labials; 57 scale rows around the middle
of the body; scales smooth, imbricate; limbs well developed, over-
lapping when adpressed; pentadactyle; claws semiretractile;
teeth short, with rounded crowns; tail cylindrical.

² Of which Dr. Charles H. Townsend obtained four specimens March 5, 1891, when
he visited Malpelo Island on the Fish Commission Steamer Albatross. Dr. Townsend
observed these lizards running over the rocks near the water. He found the “island
too steep to afford a landing, but the lizards were shot off or whisked off the face of
the cliffs, thus falling into the water, whence they were secured by the collector.” See

³ Collected by Mr. Frank Tose, and identified by Miss Mary E. McLellan, Assistant
Curator Department of Ornithology and Mammalogy, California Academy of Sciences.
Dorsal and lateral regions metallic black, profusely marked with minute creamy-white dots, except the upper surface of the tail, which may be sparingly marked; under surfaces brownish or whitish, the abdominal scales white, or having white centers; white coloring of gular region sometimes forming longitudinal lines; both upper and lower surfaces of limbs profusely spotted with creamy-white.

Total length of the type 425 mm.; width of head 40; body 230; tail 195; fore limb 56; hind limb 75.

The nine cotypes, all in the Museum of the California Academy of Sciences, present the following measurements:

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<th>Body</th>
<th>Fore limb</th>
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_Type:_ No. 62,582, Mus. Calif. Acad. Sci., collected by Joseph R. Slevin, December 20, 1927, on Malpelo Island.

It affords me great pleasure to name this new species in honor of Captain G. Allan Hancock, who very kindly made a stop at the island while _en route_ to Balboa, Canal Zone, when returning from the Galapagos Islands. My thanks for securing this lizard are also due Mr. J. T. Boumphrey, who proved himself an excellent boatman and landed me on the island despite the somewhat unfavorable weather conditions.

This species appears to be closely allied to _Celestus millepunctatus_ O'Shaughnessy, a single specimen of unknown habitat, collected by Lieutenant Wood on the voyage of _H. M. S. Herald_, 1845-1851, from which the present species differs in coloration, in having two postnasal plates, a greater number of chin shields and supraoculars, and in the development of the limbs.

All of the specimens collected by me were taken on a rocky ledge within a few feet of the water's edge. When wounded
they did not hesitate to take to the water and, on several occasions, ran into the small tide pools, leaving nothing but the head exposed.

The food of these lizards seems to consist principally of small crabs, which are abundant on the island. A piece of crab leg 36 mm. in length was taken from the stomach of one of the specimens collected. Besides this, several small feathers, presumably from some sea bird, were found in the same stomach. Other lizards of the series collected were found to contain both feathers and the remains of crabs.
Celestus lunencki Sleivin. From the type. One-third natural size.
DESCRIPTIONS OF TWO NEW SPECIES OF FISHES
FROM OFF CAPE SAN LUCAS, LOWER CALIFORNIA

BY
BARTON WARREN EVERMANN
AND
H. WALTON CLARK

In June, 1927, Mr. Albert E. Colburn of Los Angeles, California, sent to the Museum of the California Academy of Sciences the skins of two large fishes. Of the first, a species of Seriola, he wrote: “It certainly has all the characteristics of the Yellow-tail [Seriola dorsalis], excepting that of color, in which respect it differs widely.” Careful examination, however, shows it to be different in certain other respects, as will be shown by the following description:

Seriola colburnii, new species

Plate 27

Head 3.5 in body length; depth 3.6; D. V-I, 30; A. II, I, 21; scales small and irregular, about 22-167-30; eye 7.6 in head; snout 2.4; mandible 2.1; maxillary 2.4, broad, fanninged, with a broad fanninged accessory bone, its edge slipping under the overlapping edge of the preorbital, barely reaching anterior margin of orbit; head naked, except cheeks, which are well covered with ordinary scales; occipital crest rather prominent. Pectorals rather broad, the rays 21, the length 2.07 in head; ventrals somewhat narrower than pectorals but of the same length; soft dorsal characterized by a high falcate lobe, the
membrane of the lobe being thick and leathery, the longest ray 1.6 in head and considerably more than half depth of body; anal with a similar thick, falcate lobe, its longest ray 1.26 in head.

Color, upper third of body dark leaden, lower two-thirds somewhat silvery; pectoral, dorsal and anal dusky with a wash of yellow; ventrals paler, caudal dusky.

Type: No. 2164, Mus. Calif. Acad. Sci., 49 inches long, caught by Mr. W. J. Hole, in June, 1927, off Cape San Lucas, Lower California. No other specimens are known.

The fish represented by the skin in our collection differs from all the other Pacific species known to us in the high falcate anterior lobe of the soft dorsal and anal, the longest ray in each being more than half depth of body. This feature is most nearly approached in Seriola dorsalis and S. grandis, as shown by published figures, but is hardly marked in S. purpurascens and S. sparna. In this feature, in color, and count of dorsal and anal rays, our specimen approaches most closely to the Atlantic S. falcata, which, in addition to having an entirely different distribution, is a smaller, deeper fish.

We name this species for Mr. Albert E. Colburn as a slight recognition of his interest in fishes and his kind thoughtfulness in sending us interesting specimens of fishes from time to time.

A few days later we received from Mr. Colburn the skin of another large fish also taken by Mr. W. J. Hole.

This fish apparently represents a new family, the Jordanichthyidae, in some respects intermediate between the spariform and non-spariform percoids. In the absence of a skeleton its relationships cannot be clearly ascertained. The specimen upon which the species is based bears, however, a striking, even if superficial, resemblance to certain members of the Lutianidae near which this family probably belongs. The family derives its name from the type genus Jordanichthys, named for Dr. David Starr Jordan, who at once recognized the specimen as a representative of a new family. The genus may be briefly described as follows:
Jordanichthys, new genus

Type: Jordanichthys holei Evermann & Clark, new genus.

Percoids resembling the spariform percoids in having the maxillary slipping in a groove in the edge of the broad preorbital, the groove, however, shallow; accessory ventral scale, if present at all, represented by a small rudiment. No lateral line.

It is with real pleasure that we name this new genus for Dr. David Starr Jordan, Nestor of American ichthyologists and our friend and mentor for half a century.

Jordanichthys holei, new species

Boca fuerte. Plate 28

Body length 42 inches. Head 3.37 in body; depth 3.88; eye 8.6 in head; snout 2.22; maxillary 2.22 = snout; mandible 2.02; D. X, 13 or rather VII, I-I-I, 13, part of the membrane lacking (perhaps abnormal); origin of dorsal above base of pectoral; A. III?, 8 (some of the spines removed), the fin very short in base; base appearing as if with a scale-like peduncle. P. 16, base narrow, fifth ray longest, the fin acute, length of longest ray 1.7 in head, its tip reaching beyond tip of ventral; V. I, 5, its rays coarse and strong, second ray longest, 2.3 in head. No lateral line. Scales 17-60, the scales large, thin, parchment-like, cycloid, covered to near the edge with thin, lead-colored tinfoil-like skin, the exposed portion of scale deeper than long. Caudal with about 22 rays, slightly emarginate, its membranes and those of the soft dorsal densely scaled.

Cheeks and opercles scaly, rest of head naked. Premaxillary protractile; maxillary moderately broad and thick, with a ridge about the center, its posterior margin a convex arc, its anterior slightly concave. It slips partly into a shallow groove under the edge of the very broad preorbital; a peculiar truncate lobe at the end of the groove. Teeth, a few large canines in upper jaw, and a row of smaller ones in the lower jaw, irregular villiform patches on the large thick tongue: villiform teeth on palatines, none on vomer. Axil of pectoral and its posterior base scaleless, forming a leathery patch, above which is a leathery lobe perhaps representing an accessory
scale; anterior base of pectoral scaled; a somewhat larger scale at base of ventrals; interorbital a high crest about twice width of eye; preopercle very minutely serrate. The large round scales remind one rather strikingly of those of the parrot-fishes.

A photograph of another specimen of the same species, marked “Cape San Lucas, Mar. 15, 1927” and contributed by Mr. Colburn, shows a marked difference in the anal fin, which, unlike that of the type, shows a broad base (broader than depth of caudal peduncle), a much greater length (longest ray about 1.25 in base of fin), and the outline of the fin broadly rounded. This form and size of anal is probably more characteristic of the species than that of the type.

Of the type specimen Mr. Colburn wrote: “This specimen was taken in March, 1927, at Cape San Lucas, Lower California, by Willitts J. Hole of Los Angeles. The species is apparently common along the rocky shores where the water is sufficiently deep to offer sea-room. A number of these were caught by our fishermen with trolling spoons as lures. The natives refer to it as Boca fuerte, but up to date we have been unable properly to identify it. It is a strong and vigorous fighter and difficult to land on account of the fighting strength as well as its habit of anchoring beneath a rock with the subsequent breaking of the line. It is a dull brownish-olive along the back, shading into a deep reddish pink on the sides and gradually blending into a pale salmon-pink throughout the entire belly area, and shows a brilliant iridescence when first taken from the water.”

_Type:_ No. 2165, Mus. Calif. Acad. Sci., a specimen 46.75 inches long, taken in March, 1927, by Willitts J. Hole, at Cape San Lucas, Lower California.

We take pleasure in naming this very interesting species for Mr. Willitts J. Hole, ardent angler of Los Angeles, Calif., who takes a scientific interest in the fishes he captures and who has preserved many of them for scientific study.
Seriola collurio Evermann & Clark

From the type
XXIII

REPORT OF THE PRESIDENT OF THE ACADEMY
FOR THE YEAR 1927

BY

C. E. GRUNSKY
President of the Academy

During the year 1927 the Academy has done further useful work, as will appear from the following brief summary of activities, and from the reports of the Director of the Museum and of the Curators of the Academy’s various departments. The only disappointment lies in the fact that another year has rolled by without means being in sight for additions to the Academy building in Golden Gate Park. More space is urgently needed. In the fields for scientific investigation and extension of the collections of material to be studied in the Academy’s research laboratories, there is no limit except as imposed by inadequate financial resources. So, too, in the matter of keeping exhibits on display which are attractive in appearance and which have educational value, the Academy has done all that its financial resources supplemented by the generosity of an occasional public-spirited citizen would permit.

May 22, 1928
The present membership is made up of:

- Patrons: 19
- Honorary members: 19
- Life members: 83
- Fellows: 32
- Members: 948

Total: 1101

On January 1, 1927, the number of members stood at: 1076
New members added during the year: 112
Members lost by death: 26
Members resigned: 33
Members dropped for non-payment of dues: 28

Net gain during the year: 25

Leaving the membership on January 1, 1928, at: 1101

The Academy carries on its list of patrons the following names:

**Living**

- Mr. George C. Beckley
- Dr. Frank E. Blaisdell, Sr.
- Mr. William B. Bourn
- Mr. William H. Crocker
- Mr. Peter F. Dunne
- Dr. Barton Warren Evermann
- Mr. Herbert Fleishhacker
- Mr. W. M. Giffard
- Mr. Joseph D. Grant
- Mr. Edward Hohfeld
- Mrs. Albert Koebele
- Mr. A. Kingsley Macomber
- Mr. John W. Mailliard
- Mr. Joseph Mailliard
- Mr. M. Hall McAllister
- Mr. Ogden Mills
- Mr. William C. Van Antwerp
- Mr. Edward P. Van Duzee
- Dr. E. C. Van Dyke

**Deceased**

- Mr. William Alvord
- Mr. Charles Crocker
- Mr. John W. Hendrie
- Mr. Henry M. Holbrook
- Mrs. Charlotte Hosmer
- Mr. James Lick
- Mr. Alexander F. Morrison
- Mr. Amariah Pierce
- Mr. Ignatz Steinhart
- Dr. John Van Denburgh
Those who were called by death during 1927 are as follows:

- Mr. Richard Altschul... Member... November, 1927
- Mr. Edward F. Bent... Member... November 26, 1927
- Mr. Howard Brickell... Member... January 16, 1927
- Mr. W. I. Brobeck... Member... July 27, 1927
- Mr. Edmund C. Burr... Member... September 2, 1927
- Mr. Wigginton E. Creed... Member... August 6, 1927
- Dr. William H. Dall... Life member... March 27, 1927
- Prof. Edwin Theodore Dumble... Member... January 26, 1927
- Dr. Carl H. Eigenmann... Honorary member... May 25, 1927
- Mr. William F. Herrin... Life member... February 28, 1927
- Mr. Henry E. Huntington... Member... May 23, 1927
- Mr. Alfred W. Manning... Life member... September 30, 1927
- Dr. C. C. Nutting... Honorary member... January 23, 1927
- Mr. James R. Pringle... Member... September 1, 1927
- Mr. Ferdinand Reis, Jr... Member... July 22, 1927
- Mr. Albert M. Rosenbaum... Member... November 3, 1927
- Prof. Charles Sprague Sargent... Honorary member... March 22, 1927
- Prof. George O. Sars... Honorary member... April 10, 1927
- Mr. Henry T. Scott... Life member... June 27, 1927
- Mr. John R. Scupham... Life member... May 30, 1927
- Mr. Henry Hamilton Sherwood... Member... December 9, 1927
- Mr. H. A. Snow... Member... July 28, 1927
- Mr. Jacob Stern... Member... July 28, 1927
- Mr. Chas. B. Turrill... Member... May 11, 1927
- Dr. Chas. D. Walcott... Honorary member... February 9, 1927
- Mr. Mountford S. Wilson... Member... April 21, 1927

In the year 1927 eleven free lectures were delivered at the stated meetings of the Academy as follows:

**January 5**... The Probable Source of Oil in Colombia and Venezuela, by Mr. F. M. Anderson, Honorary Curator, Department of Paleontology, California Academy of Sciences, San Francisco.

**March 2**... Educational Activities in the National Parks, by Mr. Ansel F. Hall, Chief Naturalist in Charge of the Educational Division, National Park Service.

**April 6**... A Tour of American Museums, illustrated, by Mr. Frank Tose, Chief Taxidermist, California Academy of Sciences, San Francisco.

**May 4**... The Pearl Button Industry, illustrated, by Mr. H. Walton Clark, Assistant Curator, Department of Fishes, California Academy of Sciences, San Francisco.
JUNE 1 More about Pearls and Pearl Buttons, illustrated, by Mr. H. Walton Clark, Assistant Curator, Department of Fishes, California Academy of Sciences.


AUGUST 3 Something about the Sunflower Family, illustrated, by Dr. Sidney F. Blake, Associate Botanist, Department of Agriculture, Washington, D. C.

SEPTEMBER 7 General Impressions abroad with special reference to Aquariums and Museums, illustrated, by Dr. C. E. Grunsky, President, California Academy of Sciences.

OCTOBER 5 Early Reminiscences of the California Academy of Sciences, illustrated, by Col. George C. Edwards, First Vice-President, California Academy of Sciences.

NOVEMBER 2 Observation on the Autumn Birds of the Santa Rita Mountains, Arizona, illustrated, by Miss M. E. McLellan, Assistant Curator, Department of Ornithology and Mammalogy, California Academy of Sciences.

DECEMBER 7 A Problem in Animal Distribution in Southern Arizona, illustrated, by Mr. Harry S. Swarth, Curator, Department of Ornithology and Mammalogy, California Academy of Sciences.

The Sunday lectures at the Museum of the Academy in Golden Gate Park retain their popularity, and the kindness and good-will of those who contribute of their knowledge and experience on these occasions is sincerely appreciated. The following were delivered during the year 1927:

JANUARY 9 The Common Cold, by Dr. W. F. Cheney, Clinical Professor of Medicine, Stanford School of Medicine, San Francisco.

JANUARY 16 Pain in the Back, its Nature and Causes, illustrated, by Dr. Arthur L. Fisher, Associate Clinical Professor of Orthopedic Surgery, Stanford School of Medicine, San Francisco.

JANUARY 23 What do we know about Cancer, by Dr. Ludwig A. Enge, Associate Clinical Professor Gynecology, Stanford School of Medicine, San Francisco.
January 30...Chinese Medicine, by Dr. Emmet Rixford, Professor of Surgery, Stanford School of Medicine, San Francisco.

February 6...The Recent International Congress on Tuberculosis, by Dr. Robert A. Peers, Medical Director, Colfax School for the Tuberculous, Colfax, California.

February 13...The Prevention of Food Poisoning, illustrated, by Dr. Karl F. Meyer, Professor of Bacteriology and Director of The Hooper Foundation for Medical Research, University of California.

February 20...Psychoanalysis, False and Genuine, by Dr. E. W. Twitchell, Assistant Clinical Professor of Neurology, University of California, and Director of the Psychopathic Ward, San Francisco Hospital.

February 27...Chasing Phantoms, by Dr. J. M. Wolfsohn, Associate Professor of Mental and Nervous Diseases, Stanford School of Medicine, San Francisco.

March 6...Goitre, illustrated, by Dr. Wallace I. Terry, Professor of Surgery, University of California.

March 13...The Ductless Glands, illustrated, by Dr. H. Lisser, Chief Ductless Glands Clinic, University Hospital, and Assistant Clinical Professor of Medicine, University of California.

March 20...The Causes and Treatment of Anemia, by Dr. Ernest H. Falconer, Associate Clinical Professor of Medicine, University of California.

March 27...Tropical Diseases in California, by Dr. A. C. Reed, Associate Professor of Medicine, Stanford School of Medicine, San Francisco.

April 3...The Exploration of the Island of Mindoro, Philippine Islands, illustrated, by Captain A. I. Eagle of the U. S. Air Corps.

April 10...Field Notes in Alaska, by Mr. George Haley, Professor of Biology, St. Ignatius College, San Francisco.

April 17...Parasitism in Nature, illustrated, by Dr. C. A. Kofoid, Professor of Zoology, University of California.

April 24...Practical Benefits of Experimental Biology, by Dr. William Ophuls, Dean of the Medical School and Professor of Pathology, Stanford School of Medicine, San Francisco.

May 1...Modoc Lava-Beds National Monument, illustrated, by Mr. Paul J. Fair, in Charge of Exhibits, United States Forest Service.
May 8........ Is it possible to predict California's Rainfall several months in advance, illustrated, by Mr. E. A. Beals, Consulting Meteorologist, Alameda, California.

October 2..... Popularizing Science through the Public Press, illustrated, by Dr. William Emerson Ritter, President, Science Service, Washington, D. C.

October 9..... Golden Gate Park as a Botanical Garden, illustrated, by Miss Alice Eastwood, Curator, Department of Botany, California Academy of Sciences, San Francisco.


October 23.... California's Forest Resources, illustrated, by Mr. J. W. Nelson, Assistant District Forester, United States Forest Service, San Francisco.

October 30.... California's Opportunity, illustrated, by Captain Clark G. Sauers, in charge of State Parks, Indiana Conservation Commission, Indianapolis, Ind.

November 6... The Grand Canyon of the Colorado, illustrated, by Mr. Harold Stein, Educational Director of the Boy Scouts, San Francisco.

November 13... Delphiniums, by Major Newell Vanderbilt, San Rafael.

November 20... Plant Breeding, illustrated, by Mr. G. P. Rixford, Librarian, California Academy of Sciences, San Francisco.

November 27... Some Traces of Early Man, by Dr. John Sterling Kingsley, Emeritus Professor of Zoology, University of Illinois.

December 4... The California Academy of Sciences: Its Organization, History, Purposes, and Accomplishments, by Dr. Barton Warren Evermann, Director of the Museum and of the Aquarium of the California Academy of Sciences.

December 11... Organization and Purposes of the Department of Botany, by Miss Alice Eastwood, Curator, Department of Botany, California Academy of Sciences.

December 18... Organization and Purposes of the Department of Paleontology, by Dr. G. Dallas Hanna, Curator, Department of Paleontology, California Academy of Sciences.
LIST OF ACADEMY PUBLICATIONS IN 1927

The scientific activities of the Academy are reflected in large part in its publications. These have been as follows in 1927:

OCCASIONAL PAPERS, XIII—CRETACEOUS DIATOMS FROM CALIFORNIA, by G. Dallas Hanna; pp. 1-49, plates 1-5. (Issued September 17, 1927.)

PROCEEDINGS, FOURTH SERIES


Vol. XVI, No. 1, pp. 1-51, 3 text figures—NOTES ON BIRDS OF SINALOA AND NAYARIT, MEXICO, IN THE FALL OF 1925, by M. E. McLellan. (Issued January 31, 1927.)

Vol. XVI, No. 2, pp. 53-85, plate 1, text figures 1-4—A CONTRIBUTION TO THE CLIMATOLOGY OF THE ICE AGE, by C. E. Grunsky. (Issued January 31, 1927.)

Vol. XVI, No. 3, pp. 87-95, plates 2, 3—THE MARINE MIocene DEPOSITS OF NORTH COLOMBIA, by Frank M. Anderson. (Issued January 31, 1927.)


Vol. XVI, No. 5, pp. 123-135, plate 4—EXpedition of the california academy of sciences to the gulf of california in 1921. marine mOLlusca of the order opisthobranchiata, by Fred Baker and G. Dallas Hanna. (Issued April 22, 1927.)

Vol. XVI, No. 6, pp. 137-157, plate 5—EXpedition of the california academy of sciences to the gulf of california in 1921. geology and paleontology, by G. Dallas Hanna and Leo George Hertlein. (Issued April 22, 1927.)

Vol. XVI, No. 7, pp. 159-203, plates 6-12, 3 text figures—EXpedition to guadalupe island, mexico, in 1922. land and freshwater molusks, by H. A. Pilsbry. (Issued April 22, 1927.)
Vol. XVI, No. 8, pp. 205-229, plates 13, 14—Foraminifera from the Eocene near Coalinga, California, by Joseph A. Cushman and G. Dallas Hanna. (Issued April 22, 1927.)

Vol. XVI, No. 9, pp. 231-259, plates 15, 16—The Making of a Scientific Collection of Reptiles and Amphibians, by Joseph R. Slevin. (Issued April 22, 1927.)

Vol. XVI, No. 10, pp. 261-359, 1 text figure—The Birds and Mammals of Modoc County, California, by Joseph Mailliard. (Issued April 27, 1927.)

Vol. XVI, No. 11, pp. 361-363—New Species of Ceanothus, by Alice Eastwood. (Issued April 27, 1927.)

Vol. XVI, No. 12, pp. 365-380, 4 text figures—Records and Descriptions of Western Bumblebees (Bremid.), by Theodore H. Frison. (Issued April 27, 1927.)

Vol. XVI, No. 13, pp. 381-395—Expedition of the California Academy of Sciences to the Gulf of California in 1921. The Chrysomelidae (Coleoptera), by H. C. Fall. (Issued April 27, 1927.)

Vol. XVI, No. 14, pp. 397-499, text figures 1-287—A Study of the Terminal Abdominal Structures of Male Diptera (Two-winged Flies), by Frank R. Cole. (Issued April 27, 1927.)


Vol. XVI, No. 16, pp. 509-515—A Geologic Section in the Center of the San Joaquin Valley, California, by J. A. Taff and G. D. Hanna. (Issued April 27, 1927.)

Vol. XVI, No. 17, pp. 517-571, 1 text figure—A Revision of the Genus Orthocarpus, by David D. Keck. (Issued June 11, 1927.)

Vol. XVI, No. 18, pp. 573-604—A Contribution to our Knowledge of the North American Conopid. (Diptera), by M. C. Van Duzee. (Issued June 11, 1927.)

Vol. XVI, No. 19, pp. 605-647, plates 17-21—Paleontology of the Miocene of Lower California, by Leo George Hertlein and Eric Knight Jordan. (Issued September 2, 1927.)

Vol. XVI, No. 20, pp. 649-680, plates 22-24—Notes on New or Rare Fishes from Hawaii, by David Starr Jordan, Barton Warren Evermann and Shigeho Tanaka. (Issued November 14, 1927.)
Interesting Items

The financial standing of the Academy appears in the Treasurer's Report. It is not necessary to review the same; but attention may be called to the fact that the indebtedness to the Hibernia Savings and Loan Society is being steadily reduced, about $10,000 per annum. This loan represents the balance of what was borrowed after the destruction of the Academy building on Market Street in 1906, and now amounts to $215,000. The income from the Market Street property in 1927 was $89,000. The interest charges on borrowed money amounted to $12,042. Except for an investment of $1,650 in the purchase of American Trust Company stock, the net income of the Academy has been expended in the care and maintenance of its property and in furthering research work and expansion of its collection of natural history material.

It is with much gratification that I note valuable legal services rendered the past year by Mr. Edward Hohfeld, who in the same generous spirit as his predecessor, the late Mr. Alexander F. Morrison, volunteered his services. During the year his name has been added to the list of patrons of the Academy.

Important changes in the personnel of the Academy were the resignation of Mr. W. W. Sargeant, Secretary to the Board of Trustees, July 1, and the appointment to the position of Susie M. Peers, who for 12 years had been the efficient Secretary to the Director. Mr. Sargeant had been the faithful and very efficient secretary of the Board of Trustees since June 5, 1913. His resignation is a real loss to the Academy. Every member of the Board of Trustees, the Council and the Museum and Aquarium staffs will miss him greatly.

Besides lesser expeditions made by Curators and their assistants, opportunity was afforded to Mr. Joseph R. Slevin, Assistant Curator, Department of Herpetology, and our Chief of Exhibits, Mr. Frank Tose, to visit the Galapagos Islands as the guests of Captain G. Allan Hancock, late in the year. They secured material and made studies essential for future installations of groups of turtles and iguanas, for which, however, no space is yet in sight.
The large number of visitors to the Academy’s museum, and to the Steinhart Aquarium give ample proof of the appreciation by the public of the Academy’s effort to satisfy the universal demand for information on natural history subjects. Much more could be done if the available funds were more ample. Portable exhibits for school use, and lecturers in constant attendance at the museum may be suggested in this connection as features that could be added, but the need for these is overshadowed by the much greater need for additions to the Academy buildings.

Some day, it is hoped, not too far in the future, some generous friend of the natural sciences will provide the endowment that will make adequate additions possible, and some day perhaps a successful appeal may be made to the City of San Francisco to provide the funds for an expansion of the Steinhart Aquarium. Fine though this aquarium is, it does not yet fully meet the aspiration of the Academy, to maintain at San Francisco an establishment in which the wealth of the aquatic life in stream and ocean from all parts of the Pacific and its shores can be adequately displayed.

With sincere appreciation on the part of the officers of the Academy, for the loyal efforts of all who have contributed to its activities and have aided in its work, and counting on like further support, the Academy enters upon another year of service.
XXIV

REPORT OF THE DIRECTOR FOR THE YEAR 1927

BY

BARTON WARREN EVERMANN

Director of the Museum and of the Aquarium

The Annual Report of the Director for the year 1926 was presented to the Academy at the Annual Meeting, February 16, 1927.

The present report sets forth briefly the scientific and educational activities for the calendar year 1927.

The year has been an active one. Commendable progress has been made in all the departments. The members of the clerical force have performed their duties faithfully and efficiently. The members of the scientific staff have, as in the past, been active and efficient in building up and caring for the research collections in their respective departments, and in research work based on those collections.

Personnel

The personnel of the Museum has had a few important changes in the year. On February 28, Mr. Joseph Mailliard resigned his position as Curator of the Department of Ornithology and Mammalogy, and on the same date was appointed Curator Emeritus of that department. The position made vacant by Mr. Mailliard's resignation was at once filled by the appointment of Mr. Harry S. Swarth, effective March 1.

Mr. Mailliard became a member of the Academy in 1897. In 1919 he became a Patron, and on February 1, of the same year, he was appointed Honorary Curator of Ornithology and Mammalogy. This title was changed to that of Curator in 1920. Although relieved of administrative burdens, Mr. Mailliard continues to give the Academy the benefit of his counsel and is active in field and laboratory studies of birds and mammals.
Mr. Swarth had been Curator of Birds in the Museum of Vertebrate Zoology, University of California, since 1916, and has contributed greatly to our knowledge of the birds and mammals of western America. The Academy is therefore very fortunate in having in its Department of Ornithology and Mammalogy the active services of Curator Emeritus Mailliard, Curator Swarth and Assistant Curator Mary E. McLellan.

The employees of the Museum January 1, 1928, were as follows: Dr. Barton Warren Evermann, Director and Executive Curator of the Museum, and Editor of the Academy publications; Susie M. Peers, Secretary to the Board of Trustees; Joseph W. Hobson, Recording Secretary of the Academy; Alice Eastwood, Curator, and Mrs. Kate E. Phelps, assistant, Department of Botany; Edward P. Van Duzee, Curator, Hartford H. Keifer, Assistant Curator, Dr. Edwin C. Van Dyke, Honorary Curator, Dr. Frank E. Blaisdell, Research Associate, Mr. Walter M. Giffard, Research Associate, and Dr. Frank R. Cole, Associate Curator in Dipterology, Department of Entomology; Frank Tose, Chief, and Russell Hendrick, Clara Tose, and Cecil Tose, assistants, Department of Exhibits; Dr. Barton Warren Evermann, Curator, and H. Walton Clark, Assistant Curator, Department of Fishes; Joseph R. Slevin, Assistant Curator, Department of Herpetology; Dr. Walter Kendrick Fisher, Curator, Department of Invertebrate Zoology; Ignatius McGuire, Assistant Librarian; Harry S. Swarth, Curator, Mary E. McLellan, Assistant Curator, and Joseph Mailliard, Curator Emeritus, Department of Ornithology and Mammalogy; Dr. G. Dallas Hanna, Curator, Leo George Hertlein, Assistant Curator, Frank M. Anderson, Honorary Curator, and Dr. Roy E. Dickerson, Research Associate, Department of Paleontology; Constance W. Campbell, stenographer, part time; Lucie Hicks, office assistant, part time; Raymond L. Smith, general assistant; Mabel E. Phillips, check-room attendant; William C. Lewis, janitor; Hugh Jones, assistant janitor; Mrs. Johanna E. Wilkens, charwoman; Patrick O'Brien, day watch; Archie McCarte, night watch.
The Aquarium staff and other employees January 1, 1928, were as follows: Dr. Barton Warren Evermann, Director; Susie M. Peers, Secretary, part time; Constance W. Campbell, stenographer, part time; Lucie Hicks, office assistant, part time; Alvin Seale, Superintendent; Wallace Adams, Assistant Superintendent; Miss Dora Arnold, doorkeeper; Robert J. Lanier, electrician and assistant attendant; Clynt S. Martin, chief engineer; B. T. Culleton, first assistant engineer; R. J. Fletcher, second assistant engineer; Clyde E. Guidry, chief attendant; Jack Solini, first assistant attendant; L. R. Solini, second assistant attendant; Frank J. Maxwell, relief engineer and attendant; S. J. Shenefield, carpenter and general utility man; Chester L. Duncan, assistant collector; Patrick O’Neill, janitor; Patrick McArdle, assistant janitor; James Cavanaugh, day watch.

Accessions to the Museum and Library

The accessions to the Museum and Library have been many and valuable within the year. Those to the Library through exchange, purchase, and gift have been unusually large and important, and too numerous to list; only those received by gift are listed here. Following is a list of the accessions to the Museum:


American Museum of Natural History, New York, N. Y.: 6 frogs from Porto Rico, 8 from Nicaragua, 1 from Ecuador, 2 from Jamaica, 1 from Dominica, and 1 from Costa Rica. Exchange.

Anderson, F. M., Berkeley, Calif.: 2 lizards from Kern County, Calif. Gift.

Archambault, Mr. and Mrs., Lemon, S. D.: 1 deer head covered, mounted and beaded by an Indian woman, Standing Rock Reservation, North and South Dakota. Gift.


Associated Oil Co., San Francisco: 10 samples of well cores. Gift.

Australian Museum, College Street, Sydney, Australia. 2 skulls Otaria cinerea, South Pacific Elephant Seal. Exchange.

Baker, Dr. Fred, San Diego, Calif.: 50 specimens of Marine shells. Gift.

Baker, Jack D., 435 1st Street, Santa Rosa, Calif.: 2 California Murres; 1 Baird's Cormorant; 1 Farallon Cormorant; 2 Brandt's Cormorant. Gift.

Bancroft, Griffing, 2525 First St., San Diego, Calif.: 272 bird skins from Lower California. Exchange.


Barnes, Dr. Wm., Decatur, Illinois: 618 moths, determined. Gift.


Bishop, Dr. C. S., Albany, N. Y.: 2 turtles from New York. Gift.

Blaisdell, Dr. Frank E., Sr., 1520 Lake Street, San Francisco: Skeleton of a domestic cat; 1 skunk skeleton, complete; 4 mammal skulls; 14 bird skulls; 86 Diptera from Mokelumne Hill, Calif.; 13 numbers of Science (current); Stanford University Publications, University series No. 1; 118 miscellaneous separates; 118 entomological separates; 3 unbound copies of "Plaga de La Langosta en Mexico"; Fisher, Hawks and Owls, 1893 (bound); Goss, Birds of Kansas, 1886 (bound). Gift.

Blatchley, Dr. W. S., 1530 Park Avenue, Indianapolis, Indiana: 142 Hemiptera from Florida, etc., including some paratypes. Purchase.

Braun, Miss Annette F., 3702 May Street, Cincinnati, Ohio: 67 specimens of Microlepidoptera. Gift.


California Botanical Club, San Francisco, through Miss Alice Eastwood: Humboldt and Bonpland, Monographies des Melastoma, parts 1 and 2; Miller, Philip, Figures of Plants, 2 volumes. Gift.

California Fish and Game Commission, San Francisco: 3 birds, Tinamous (3 species). Gift.
Campbell, Mrs. Constance W., California Academy of Sciences: 1 bat, *Myotis yumanensis sociabilis* (mummy); 2 Salamanders from Marin Co., Calif. Gift.


Cavanaugh, James, Steinhart Aquarium, San Francisco: 21 numbers of "Douglas 20." Gift.


Classen, John W., through Dr. G. Dallas Hanna: 1 bird's egg, *Chachalaca* (*Ortalis* sp.?). Gift.

Classen, W. J., Menlo Park, Calif.: 3 fossil Miocene fish from Lompoc, Calif.

Conolley, E. D., Holbrook Building, San Francisco: 2 Rocky Mountain Sheep heads and 1 Black-tailed Deer head. Gift.

Cottle, J. E., 2473 Post St., San Francisco: 1 paratype of *Sabulodes cotttlei* Barnes; miscellaneous insects from California. Gift.


Dickerson, Dr. Roy E., Lima, Peru: One package of Carboniferous fossils from South America. Gift.

Dudley, Chester, Modesto, Calif.: 57 plants. Gift.

Eastwood, Miss Alice, California Academy of Sciences, San Francisco: American Forests and Forest Life 1927; 34 miscellaneous numbers of Science; U. S. Dept. Agriculture, Yearbook, 1926, 1927; American Journal of Botany, 1927; Sachs, Lectures on the physiology of plants (bound); 9 quarterly issues of the Smithsonian Miscellaneous Collections; Scientific Monthly, 14 misc. numbers; Bulletin Pan-Pacific Union, 9 numbers; Mid-Pacific Magazine, Vols. 27-35; California Historical Society Quarterly, 4 volumes unbound. Gift. 85 plants from Pacheco Pass and Los Baños; 78 plants from Eldorado County; 289 plants from San Luis Obispo County; 293 plants from Plumas County; 152 plants from the State of Nevada; 80 miscellaneous. Exploration.
Evermann, Dr. Barton Warren, California Academy of Sciences, San Francisco: Connecticut Fish and Game report, 1925-1926; California Division of Water Rights Biennial report, 1926; Review of Applied Entomology, 9 numbers; San Francisco Report on Underground Water Supply, 1913, 173 pp.; 10 numbers, Columbia Port Digest; 4 numbers, Overland Monthly; 10 numbers, The Outlook; 9 numbers, Yosemite Nature Notes; 22 numbers, Science; 3 numbers, Natural History; Oklahoma Academy of Sciences Bull. Vol. 4, pts. 1, 2; 1 number, Brooklyn Museum Quarterly; 3 numbers, Roosevelt Wild Life Bull.; 2 numbers, Journal Marine Biological Association; Plymouth Aquarium Guide Book; 5 descriptive pamphlets, Marine Biological Association; Provincial Museum of Natural History report 1925; Illinois State Museum of Natural History General Guide; Museum Graphic, vol. 1, No. 1; U. S. Dept. Agric. Bulletins, 5 numbers; Pan-Pacific Food Conference, First, Proceedings; Pan-Pacific Educational Conference, First, Proceedings, 2 copies; Societe des Etudes Oceanieennes, Papeete, Bulletins 11, 12, 18, 19; Southern California Academy of Sciences, Bull., 3 numbers; American Museum of Natural History, Annual Report 1921; Bernice Pauahi Bishop Museum Director's Reports, 1902, 1905, 1900; Standard Oil Bulletin, 4 numbers; Richards, Industrial Art and the Museum (bound); Fur Journal, 1927; Canadian Fisheries Expedition, 1914-1915, 495 pp; Holder, C. F., Santa Catalina, 1895, 126 pp; American Museum of Natural History, General rules for the preparation of manuscript, 14 pp., and Styles and sizes of types, 4th ed., 20 pp; Aquatic Life, 16 numbers; Aquarium, two numbers; Amateur Aquarist, 5 numbers; Berlin Aquarium Zoologischer Garten Führer, 1925 47 pp; American Fish Culturist, 4 numbers; Catalina Islander, 15 numbers, and complete file for 1927; National Parks Nature Notes, 28 numbers; National Parks Portfolio; Parks and Recreation, 1 number; Chicago Academy of Sciences descriptive handbook 1911; “William Powell Wilson” 16 pp; Overland Monthly, 8 numbers; Sherwood, George H., Free Education by the American Museum of Natural History, 1918; The Colorado Museum of Natural History (guidebook) no date; New York Zoological Society Bulletin V. 27, No. 2; Zoologica V. 9, No. 1; Torrey, State parks and recreational use of state forests, 1926; Publications Am. Museum Assn., new series, No. 2; Museum Journal, Philadelphia, V. 7, No. 2; Amer. Museum of Natural History, Rules and Regulations, 1912; Charleston Museum Bulletin, V. 12, No. 6, 1916; Contributions to Canadian Biology, The Sea-lion Question, 1918; Santa Barbara Museum of Natural History, 1926; Proc. Calif. Acad. Sci., V. 15, No. 16, V. 12, No. 30; Toronto Univ., Studies, Biological Series, No. 24; Camera Craft, 3 numbers; National Association of Secondary School Principals, 5th yearbook, 1921; Wisconsin Magazine of History, June 1921; Report of the Underground Water Supply of San Francisco County, 1913; National Conference on Outdoor Recreation, Organization and Program, 1924-1925 (2); Joransen, Einar, The Danegeld in France, 1924; Cin-

Evermann, Barton Warren, and G. Dallas Hanna, California Academy of Sciences: 1 can of freshwater mollusks from Pyramid Lake, 2 species. Exploration.


Frierson, L. S., Jr., Shreveport, La.: 2 lizards, 5 frogs, and 12 salamanders from Louisiana. Exchange.


17 snakes and 1 lizard from Kansas; 2 snakes from Michigan. Purchase.

May 22, 1928
Grinnell, Dr. Joseph, University of California: 7 alcoholic specimens, toptotypes, of Salmo nelsoni Evermann. Gift.


Griffith, Arthur C., 207 Glen Drive, Sausalito, Calif.: 1 owl, Bubo virginianus saturatus, mounted, from Marin Co., Calif. Gift.


Haley, Professor George, Berkeley, Calif.: 1 Nunivak native spear used in spearing water birds; 510 specimens of mollusks; 2 sounding waxes; 1 bottle of sediment; 1 can of diatom-bearing mud; 1 can of minerals; 1 jar of diatom-bearing sand and grass; 1 shell from St. Lawrence Island, Alaska; 234 plants from Alaska, 36 from Nevada, and 67 from Sierra Co., Calif. Exploration.

Hall, R. Radcliffe, Barbados, B. W. I.: 4 samples of diatomaceous earth from Barbados. Exchange.

Halvorsen, E. E., Coalinga, Calif.: 12 specimens of fossil mollusks from Coalinga, Calif.; and 2 small sacks of Tertiary fossils. Gift.


Hapemen, Dr. H., Minden, Nebraska: 13 botanical specimens. Exchange.

Harrold, C. G., Winnipeg, Manitoba, Canada: 27 mammal skins and skulls, 38 skulls, and 9 skeletons, from Alaska; 555 bird skins and 10 skeletons, representing 92 species of Alaskan birds; 12 sets, 39 eggs, of eggs and nests from Alaska; and 74 plants from Alaska. Exploration.


Harter, Mrs. H. C., Lindsey, Calif.: 8 specimens of California plants. Gift.


Hertlein, Leo George, Palo Alto, Calif.: 2 boxes of Cretaceous fossils from Mexico. Gift.

Hertlein, L. G., and E. L. Rixford, California Academy of Sciences: 60 species, 1,076 specimens of marine mollusks from Santa Rosa Island; 20 species, 121 specimens of marine mollusks from San Miguel Island; and 6 boxes of Miocene fossils from Santa Rosa, San Miguel and Santa Cruz islands. Exploration.

Hill, C. L., Bureau of Forestry, Ferry Building, San Francisco: 1 Miocene beetle from mine near Quincy, Calif. Gift.


Hudson, Dr. J. W., Ukiah, Calif.: 12 specimens of California plants. Gift.

Hunt, Nelson J., 1021 Wayne St., Sandusky, Ohio: 2 seed necklaces from West Indies; and 1 seed of tropical plant (nut). Gift.


Japan National Research Council, Tokyo, Japan: Scientific Japan (bound); Souvenir of the Third Pan-Pacific Scientific Congress; Minutes of the Final Meeting, Third Pan-Pacific Scientific Congress; and 2 maps, Geology of Nippon and Earthquake of Oct. 1925. Gift.

Jones, Miss Katherine, University of California: 20 specimens of plants from New Zealand. Gift.

Kauffman, E. R., Rialto Building, San Francisco: 3 numbers of the Pacific Sportsman, completing the Academy's set to date. Gift.

Keifer, H. H., California Academy of Sciences, San Francisco: 2275 insects taken at Oroville, Calif., etc. Exploration.

2 snakes from Lower California; 7 snakes from San Diego County, Calif.; 2 salamanders from San Diego County, Calif.; and 115 toads from San Diego County, Calif. Gift.


Koebele, Mrs. Fanny, Waldkirch, Germany: 44 bird skins, and 2 land snails. Gift.


Leach, E. R., 217 Hillside Ave., Piedmont, Calif.: 32 miscellaneous insects mostly from Trinity County, Calif.; 1 snake from Mendocino County, Calif.; 52 insects from India; and 1 snake from Shasta County, Calif. Gift.
Leach, Frank A., Diablo Country Club, Diablo, Calif.: 1 bat, Corynorhinus rafinesquii townsendii, from Sonoma County, Calif.; 1 nest of Western Gnatcatcher (Polioptila carulea amanissima). Gift.

Lewis, W. C., California Academy of Sciences, San Francisco: 1 hummingbird, Selasphorus alleni, in flesh, from Golden Gate Park, San Francisco. Gift.


Martin, J. O., California Academy of Sciences, San Francisco: 1 wren, Thryomanes bewicki spilurus, in flesh, from Golden Gate Park; 89 moths taken at Alma, Calif.; Revision of the Tenebrionidae of America North of Mexico. Gift. 4865 insects from Texas; 560 insects, mostly beetles, from California; 3 Salamanders from Arizona. Exploration.


McDonald, Miss Julia, 1221 Lombard Street, San Francisco: 20 California plants. Gift.

McLaren, John, Golden Gate Park, San Francisco: 1 curassow, Crax alector, in flesh, from Golden Gate Park; 1 kangaroo, Macropus, in flesh, from Golden Gate Park, San Francisco; 1 elk, in flesh, from Golden Gate Park; 1 ostrich, Struthio camelus, in flesh, from Golden Gate Park. Gift.

McLellan, Miss Mary E., California Academy of Sciences, San Francisco: U. S. Dept. Agri. Official Record, 1927; 81 miscellaneous insects from Mazatzan, Mexico; 46 miscellaneous insects from Santa Rita Mts., Arizona; 50 freshwater shells from Niles Canyon, Calif.; 1 lizard, Phrynosoma douglassii hernandezii; 1 frog, Rana pipiens. Gift. 90 skins and skulls, and 2 alcoholics of mammals from Pima and Santa Cruz counties, Arizona; 274 bird skins from Pima and Santa Cruz counties, Arizona. Exploration.

Meadows, Don C., Avalon, Santa Catalina Island, Calif.: 1 snake, Lampropeltis getulus boylii; and 1 lizard, Uta stansburiana hesperis, from Santa Catalina Island. Gift.

Merrill, G. K., 309 Broadway, Rockland, Maine: 24 specimens of lichens. Purchase.

Mexia, Mrs. Ynez, Botanical Department, University of California: 200 specimens of Mexican plants. Purchase.


Montgomery, A. C., SS. Montagu, San Francisco: 6 birds, in flesh, from the Philippine Islands and the Celebes. Gift.

Mori, T., 1511 Geary St., San Francisco: 3 teal ducks, 1 *Nettion crecca* and 2 *Nettion formosum* from Japan? (in flesh); 1 bird, Java Nonpareil (*Erythrura prasina*); and 2 birds, Bamboo Partridge (*Bambusicola thoracica*). Gift.


Myers, Mr., Sportmans Club, San Francisco: 4 Gambel's Quail and 4 California Quail. Gift.

Nast, Dr. Ernest, 4112 24th Street, San Francisco: 488 insects, largely moths, from the Sierra of California. Gift.

National Association of Audubon Societies: Portraits and Habits of our Birds, two bound volumes; 20 pamphlets. Gift.


Oldroyd, Mrs. I. S., Stanford University, Calif.: 2 marine shells. Gift.


Otis, Ira C., Seattle, Wash.: 26 specimens of plants from Washington State. Gift.

Pacific Division, A. A. A. S.: Science News-Letter, 57 current numbers; Science, 67 current numbers; 34 catalogues of various educational institutions; Western Society of Naturalists membership roll, 1916; 26 A. A. A. S. Pacific Division announcements; American Medical Directories for 1921, 1918, 1916. Gift.


Palmer, T. Chalkley, Delaware County Institute of Science, Media, Penn.: 8 numbers of the Proceedings of Delaware County Institute of Science. Gift.


Pammel, Dr. L. H., Iowa State College: Weed flora of Iowa, 1926 edition, bound; Prominent Men I Have Met, II; and 10 separates. Gift.

Patterson, W. J., 1843 9th Ave., San Francisco: 51 specimens of various ores and minerals from California and Arizona. Gift.

Phelps, Mrs. Kate E., 580 McAllister Street, San Francisco: 7 botanical specimens from Washington State. Gift.

Piper, Dr. C. V.: 25 specimens from his herbarium. Gift.


Peterson, A., San Bruno, Calif.: 1 cetacean ear bone, obtained in New York, originally from Alexandria. Gift.

Poling, O. C., Laguna Beach, Calif.: 32 moths from Arizona and Texas. Gift.

Pomona College, Claremont, Calif.: 805 duplicate botanical specimens from the Marcus E. Jones collection. Exchange.

Pope, Dr. Emma, Panoramic Way, Berkeley, Calif.: 1 Gnu head (mounted). Gift.

Pope, Mrs. Saxton, San Francisco: 3 lantern slides of snake heads. Gift.

Reed, Miss Elizabeth Mary, 751 14th Ave., San Francisco: 1 sloth, *Bradypus* skin from Brazil. Gift.


Robison, Ansel W., 1072 Market St., San Francisco: 1 parrot, Melopsittacus undulatus, in flesh, domestic; 1 Myadestes obscurus occidentalis, in flesh, from Mexico; 1 Blue Mountain Lory (Trichoglossus); 1 Rosella Parakeet (Platycercus eximius); 1 Red-rump Parakeet (Psophotus haematotus); 1 Kagu (Rhinocheta jubata); 1 Uroloncha leucogastroides, in flesh; 1 bird, Gallinula chloropus, in flesh, from the Philippine Islands; 1 monkey, Saimiri oerstedii, in flesh, from Central America; 1 parrot, Chalcopsittacus ater, in flesh, from Ceram. Gift.

Ronneberg, Trygve, Crocker Building, San Francisco: 3 mounted birds, 1 Pavo cristata, 1 Colaptes cafer collaris, and 1 Cyanocitta stelleri frontalis. Gift.

Ruddock, George, San Francisco: Marloth's Flora of South Africa, 4 volumes in 5, quarto; bound in cloth. Gift.

Ruthling, Paul D. R., Santa Fe, New Mexico: 3 snakes from New Mexico; and 1 snake and 1 lizard from Mexico. Gift.

Sanford, Miss Helen, 152 17th Ave., San Francisco: 32 specimens of plants from San Diego. Gift.

Sargeant, W. W., California Academy of Sciences, San Francisco: Scientific Monthly, Vol. 20, Nos. 3-6; 21, complete; 22, Nos. 1-4; 23, complete; 24, Nos. 1-5; National Geographic Magazine, Vols. 48-50 complete; American Association for the Advancement of Science Proceedings for 1915 and 1921, Program, 73d meeting, 1921 (2 copies); 74th meeting, 1922; Commonwealth Club Transactions, 25 numbers; “The Commonwealth,” 54 numbers; Directories of Schools and Colleges in the U. S., 52 numbers; “Tee-Bee,” 31 numbers; Adam, Fundamental Hypotheses (bound); and Architect and Engineer, March 1924. Gift.


Seitz, Mrs. L., Atascadero, Calif.: 19 botanical specimens from California. Gift.

Sinsheimer, Gertrude, San Luis Obispo, Calif.: 24 botanical specimens from San Luis Obispo County. Gift.


6 land shells from San Diego County, Calif; and 401 specimens of reptiles from San Diego County, Calif. Exploration.
Slevin, Louis S., Carmel, Calif.: The L. S. Slevin Collection of Coleoptera, about 30,000 specimens; 1346 moths from Carmel, Calif.; 20 freshwater shells from Soledad, Calif.; 3 salamanders from Carmel, Calif. Gift.


Stanford University, California: Sample of diatomite from Lower California. Exchange.


Steinhart Aquarium, Golden Gate Park, San Francisco: 1 Nine-banded Armadillo (Tatusia novemcincta), shell and skull; and 20 salamanders from Napa County, Calif. Gift.

Stipp, Thomas F., Laredo, Texas: 1 box of Tertiary and Cretaceous fossils from Mexico and Texas; 68 bound volumes, 715 unbound parts of volumes and pamphlets on geology and related subjects; and 3 boxes of fossil shells from eastern Mexico. Gift.


Strong, A. M., Los Angeles, Calif.: 7 specimens of marine shells from various places in California. Exchange.

Sutkamp, Mrs. A. C., 2220 Funston Ave., San Francisco: 3 sets of plumes mounted for millinery purposes. Gift.

Sutcliffe, Mrs. E. C., 700 Lake Street, San Francisco: 22 botanical specimens from California. Gift.

Swanstrom, Mrs. Evelyn, Savoy Hotel, San Francisco: Abalone shells from Montaro Beach, San Mateo County, Calif. Gift.

waukee Public Museum, Yearbooks for 1921, 1922, 1923, 1924, 1925; and 8 specimens of plants from Arizona. Gift.
321 mammal skins and skulls from Arizona; 419 bird skins, 1 skeleton, 10 sets (26 eggs) of eggs, and 2 nests from Arizona; 2 lizards from Arizona. Exploration.


Takahashi, R., Dept. of Agriculture, Government Research Institute, Tokyo, Japan: 1 brochure, Aphididae of Japan, Part 5. Gift.


Taylor, Dr. W. P.: 43 specimens of plants from Arizona, Colorado and New Mexico. Gift.

Tose, Frank, California Academy of Sciences, San Francisco: 69 plants from southern California. Gift.
56 bird skins; 39 mammal skins; 9 reptile skins; 15 reptile molds and casts; 8 bird nests and eggs; 7 sketches and miscellaneous material for groups; 1 Eland head (mounted); and 128 bats, 3 species, adults and young. Exploration.


University of California, Berkeley, Calif.: 95 specimens of plants collected by Mrs. F. M. Stephens. Gift.

The University of Central Asia, Tashkent, Turkestan: 163 botanical specimens from Asia. Exchange.

Van Duzee, Edward P., California Academy of Sciences: A file of Science from 1918 to 1926; 2 small boxes of land shells. Gift.
106 insects from Carmel, Calif.; and 5139 insects from Truckee and Reno. Exploration.

Van Dyke, Dr. E. C., University of California, Berkeley, Calif.: 1964 miscellaneous insects; 28 specimens, 9 species of land mollusks; 2 land snails; 2 freshwater shells from Priest Lake, Ida.; 2 specimens, 2 species, freshwater mollusks from Sprague Lake near Ritzville, Washington; 2 land snail shells from Coeur d'Alene Lake, Ida.; miscellaneous insects from Yosemite, Calif.; 3 land shells and 2 salamanders from Alameda County, Calif., 5 from Idaho, and 3 salamanders and 2 frogs from Oregon. Gift.

Van Dyke, Mrs. E. C., 2440 Stuart Street, Berkeley, Calif.: 51 botanical specimens from Oregon. Gift.
Vortriede, William, Capitol Park, Sacramento, Calif.: 41 plants from Camp Sacramento. Gift.


Werdermann, Dr. E., Botanical Museum, Berlin, Germany: 471 botanical specimens from Chile. Purchase.


Wilder, H. E., Carlotta, Calif.: 1 Marten (*Martes caurina sierrae*); and 1 Lynx (*Lynx fasiatus oculcus*), skin, skull, and leg bones for mounting, from Humboldt County, Calif. Purchase.

Willett, George, Los Angeles, Calif.: 4 specimens of marine shells. Exchange.

Willett, Mrs. W. M., 2028 Scott Street, San Francisco: 2 birds, *Erythura prasina*, in flesh, from Java. Gift.


Woodbury, A. M., Zion National Park, Utah: 3 toads, 2 frogs, 6 lizards, 1 salamander from Zion National Park. Gift.

Worth, Chas. J., 247 Fremont St., San Francisco: 3 glass specimen jars 8" x 24". Gift.

Wright, J. T., c/o American Consul General, Shanghai, China: 3 skins, 1 complete skeleton, and 2 skulls of mammals from Annam; 36 bird skins from Annam. Purchase.

Wright, Mrs. Dora, Shanghai, China: 1426 insects from Annam. Purchase.

Wymore, J. C., University Farm, Davis, Calif.: 36 microlepidoptera from Davis, Calif. Gift.

**Cooperation with Public and Private Schools, with Other Institutions and with Individuals**

Cooperation with schools, institutions and individuals continues, as in the past, through the loan of portable exhibits and study specimens of birds and other natural history objects, and use of library, by means of lectures, and in other ways. De-
tailed records of these activities are in the Museum files. Thirteen portable habitat groups are in constant use in the Berkeley public schools, and several others will soon be available.

**Visitors to the Museum in 1927**

The total number of visitors to the Museum in 1927 was 543,014, a number greater than in any previous year except 1924, 1925 and 1926. The average daily attendance was 1488.

The number of visitors by months and years since the opening September 22, 1916, is shown in the following table:

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Total since opening of the Museum, 4,918,618.

**Schools Visiting the Museum in 1927**

The public and private schools of San Francisco and elsewhere in the state continue to find it worth while to visit the Museum, to view our public exhibits and our reference collections.

Following is a list of the schools, the grades, teachers, number of pupils, and dates of visits, in 1927:
### Schools of City and County of San Francisco

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## Schools of City and County of San Francisco—Continued

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<td>23</td>
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**Schools of City and County of San Francisco—Continued**

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**Schools Outside of San Francisco**

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<td>48</td>
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<td>* 28</td>
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<td>High 6</td>
<td>32</td>
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<td>H. Burroughs M.</td>
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<tr>
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<td>High 5</td>
<td>29</td>
<td></td>
<td>Amy Oakley</td>
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<tr>
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<td>5</td>
<td>45</td>
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<td>Zoology</td>
<td>14</td>
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<td>Tracy L. Storer</td>
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<tr>
<td>* 20</td>
<td>San Anselmo</td>
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<td>Edyth D. Walker</td>
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<td>98</td>
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<td>M. Sterne, M. Osborne and E. Abernathy</td>
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<tr>
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<td>* 9</td>
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<td>Sept. 24</td>
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<tr>
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<td>31</td>
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<td>Jessie L. Cundall</td>
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</tbody>
</table>
Summary

Schools of San Francisco:
- Total Number of Pupils: 4131
- Total Number of Teachers: 141
- Total Number of Classes: 154

Schools Outside of San Francisco:
- Total Number of Pupils: 1074
- Total Number of Teachers: 36
- Total Number of Classes: 34

Use of the Library and Research Collections by Investigators and Students

Greater use is being made each succeeding year of our Library and research collections by investigators and students. The Academy Library is becoming more and more valuable every year, not only to specialists who find in it technical publications, particularly of learned societies, to which they have not easy access elsewhere, but the general public find in it many works of reference which they wish to consult. On the Library reading tables are kept many of the current publications of learned societies throughout the world, also many of the current scientific journals, nature and outing magazines, and recent popular nature books. Members of the Academy are invited to visit the Library and avail themselves of the facilities which it affords for securing information along these and other lines in which they are interested.

Steinhart Aquarium

The activities of the Aquarium for 1927 are fully set forth in the report of the Superintendent.

It continues to be one of the greatest attractions of San Francisco. Visitors to California from other states and from foreign countries rarely fail to include the Steinhart Aquarium.
among the places of special interest which they visit. Scarcely a day passes that some one does not come to the office to express his appreciation of the excellence of the exhibits and the cleanliness and generally attractive appearance of the Aquarium. The employees of the Aquarium without exception deserve high praise for the splendid condition in which the exhibits and all parts of the Aquarium are maintained.

Following is a record by months and years of the number of visitors to the Aquarium since the opening, September 29, 1923:

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<tr>
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<th>1923</th>
<th>1924</th>
<th>1925</th>
<th>1926</th>
<th>1927</th>
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<td>44,300</td>
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<td>119,001</td>
<td>61,213</td>
<td>66,032</td>
<td>39,515</td>
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<tr>
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<td>88,172</td>
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<td>82,153</td>
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<td>64,830</td>
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<td>75,187</td>
<td>94,521</td>
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<td>145,703</td>
<td>128,261</td>
<td>127,999</td>
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<td>144,208</td>
<td>124,635</td>
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<td>29,800</td>
<td>116,032</td>
<td>106,492</td>
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<td>209,671</td>
<td>71,273</td>
<td>72,350</td>
<td>79,108</td>
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<td>145,434</td>
<td>67,500</td>
<td>59,074</td>
<td>49,741</td>
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<td>96,757</td>
<td>48,376</td>
<td>52,929</td>
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<td>Totals</td>
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<td>1,180,352</td>
<td>1,043,591</td>
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**Schools Visiting the Steinhart Aquarium in 1927**

That the Steinhart Aquarium is proving of interest and real educational value to the schools is evidenced by the great number of pupils, classes, and teachers that visit it annually.

Following is a list of the schools with names of teachers and number of pupils:

May 22, 1928
### Schools Visiting Steinhart Aquarium in 1927

<table>
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<tr>
<th>Date</th>
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<th>Teachers</th>
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<tr>
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<td>48</td>
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<td>5-7</td>
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<td>A. M. Alcorn</td>
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<td>Low 8</td>
<td>12</td>
<td>Miss Puter</td>
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<td>High 2</td>
<td>16</td>
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<td>A. Ringchop, C. Doyle</td>
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<td>LeConte</td>
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<td>Freshmen</td>
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<td>E. Stockton</td>
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<td>25</td>
<td>G. L. Allen</td>
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<td>*</td>
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<td>*</td>
<td>Paul Revere</td>
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<tr>
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**SCHOOLS OUTSIDE OF SAN FRANCISCO**

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## Schools Outside of San Francisco—Continued

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<td>* 27</td>
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<td>South San Francisco Grammar</td>
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<td>T. Wakabayashi</td>
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<td>* 29</td>
<td>Washington, Alameda</td>
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<td>Miss Kone</td>
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<td>Dec. 6</td>
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<td>Jessie L. Cundall</td>
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<td>Concord Grammar</td>
<td>7-8</td>
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<td>Guardian Adeline Laughlin</td>
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</table>
Summary

Schools of San Francisco:
Number of Visiting Pupils.......................... 5214
Number of Visiting Teachers........................ 169
Number of Visiting Classes......................... 177

Schools Outside of San Francisco:
Number of Visiting Pupils.......................... 2146
Number of Visiting Teachers........................ 69
Number of Visiting Classes......................... 78

Total Number of Pupils.............................. 7360
Total Number of Teachers........................... 238
Total Number of Classes............................. 255

Department Activities

The activities of each of the various departments of the Museum during the year 1927 have not lagged behind those of previous years. The usual attention has been given to accessioning, arranging and care of the research collections, each of which has grown steadily from donations and purchase and through the field activities of the curators and their assistants. Full details will be found in the various departmental reports. Only brief summaries need be given here.

Department of Botany.—As in 1926, Miss Eastwood made a number of short collecting trips to certain parts of the state for the purpose of securing specimens to fill gaps in the Herbarium, of clearing up doubtful matters in geographic distribution, and in making life-history studies of certain species. The Herbarium grew greatly in the year, by purchase, gift, and exchange, and from exploration. Perhaps the most valuable collection resulting from field work of the year was that obtained on Nunivak Island and elsewhere in Alaska by Mr. C. G. Harrold and Prof. George Haley.

According to the Curator’s report, the Herbarium now contains 151,501 sheets of mounted specimens, an increase of 7935 during the year.

Department of Entomology.—The Curator, Mr. Edward P. Van Duzee, reports that the principal work of his department
during the year was curatorial in character,—sorting, labelling, arranging, and caring for specimens already on hand and needing attention, including several large collections recently received, notably the Van Dyke and Koebbele collections. Another notable donation made to the department within the year was the collection of beetles by Mr. Louis S. Slevin of Carmel. This collection numbers about 25,000 specimens, and contains many rare and interesting species.

Department of Exhibits.—Mr. Frank Tose, Chief of Exhibits, has been busy during the year with the various duties and activities that usually have to be attended to by the taxidermists, preparators, and artists of a small museum such as ours. As an illustration, the Museum receives each year as donations from Superintendent McLaren a considerable number of birds and mammals that have died in Golden Gate Park. As these are received in the flesh, they require immediate attention, as we usually find them worth saving. All this takes a good deal of the time of the department. The preparation of habitat groups continued, and now every available space in the Museum has been filled. The last groups to be installed are the Bat group and the California Gray Squirrel group, two unique and very attractive exhibits.

In addition to the regular work of the department, Mr. Tose, assisted by Mr. Slevin, installed a very creditable exhibit at the Pacific Foreign Trade and Travel Exposition held in the City Auditorium, in September. This exhibit is fully described in Mr. Tose's report.

Department of Fishes.—During the first eight months of the year 1927, the assistant curator devoted most of his time to the completion of the manuscript for a revised Check-List of Fishes and Fish-like Vertebrates of North and Middle America, upon which Dr. David Starr Jordan and the curator have been engaged from time to time for many years as their other more pressing duties would permit. This monumental work, including indexes to both scientific and vernacular names, was completed and sent to the Bureau of Fisheries at Washington in August, 1927, by which it has been accepted for publication.
The reference series of fishes which the department is building up for the use of the Aquarium, anglers, and others interested in fishes, is growing rapidly. This is being added to from time to time, the additions coming chiefly from the Aquarium and from field parties sent out by the Academy and the Aquarium. Most important among these is the very large collection made in 1925 by the Academy’s expedition to the Revillagigedo and the Tres Marias islands.

Department of Herpetology.—Mr. Joseph R. Slevin, Assistant Curator of this department, was active throughout the year chiefly in curatorial work such as recording, labelling, card-cataloguing, and caring for the recent accessions, particularly the amphibians.

The exhibit made by the Departments of Exhibits and Herpetology at the Pacific Foreign Trade and Travel Exposition has already been mentioned.

In April and May Mr. Slevin spent some time in San Diego County where a considerable collection of reptiles was obtained, some of the species obtained being rare.

Perhaps the most important single event in the department’s activities in the year was a trip made by Mr. Slevin and Mr. Tose to the Galapagos Islands in November and December on the SS. Oaxaca as guests of Captain G. Allan Hancock, for the purpose of securing accessory materials for certain habitat groups which the Academy proposes to install, including one each of the large Land Iguana (Conolophus subcrisatus), the Aquatic Iguana (Amblyrhynchus cristatus), and a species of gigantic tortoise.

In addition to securing materials for these groups, they had opportunity to do some general collecting. For the Department of Ornithology they secured a good series of the Flightless Cormorant (Nannopterum harrisi), for the Department of Herpetology a good series of the Land Iguana and the Aquatic Iguana.

Perhaps the event of most scientific importance to the Department of Herpetology, certainly the most spectacular, was the securing on Malpelo Island off the coast of Colombia, not only of a fine series of 27 specimens of Agassiz’s Lizard, Anolis agassizii Stejneger, previously known only from four specimens taken on this island in 1891 by Charles H. Town-
send, but 10 specimens of another species of lizard entirely new to science, which Mr. Slevin will soon\(^1\) describe in these Proceedings.

Malpelo Island is a small rock projecting above the water like a castle, landing upon which is next to impossible. Dr. Townsend secured his four specimens by shooting them from the face of the cliff and picking them up from the water as they fell near the boat from which he was unable to make a landing.

Though the sea was quite rough and the shore in most places nearly perpendicular, Mr. Slevin succeeded in making a landing, the first ever made upon the island by any human being so far as known.

**Invertebrate Zoology.**—The Curator has not been able to devote any time to this department in the past year further than to care for the collections already on hand. It is hoped that we may soon have suitable rooms for this department and that funds to place it upon the same basis as the other departments may become available.

**Library.**—The report of the Assistant Librarian, Mr. I. M'Guire, indicates that the growth of the Library during the past year has been the most satisfactory in its history. This has been due first, to the generous allotment of funds made by the Council and Trustees for library purposes, and second, to the careful and intelligent attention to its needs given by Mr. M'Guire, who has been very active in completing our files of the publications of learned societies, calling attention to desirable exchanges and to early scientific reports, books, and pamphlets, listed for sale rarely and only by second-hand book dealers, also in improving the library generally.

Mr. M'Guire in his report calls attention to several of the most urgent needs of the Library. It is hoped these may receive the early attention of the Council.

**Department of Ornithology and Mammalogy.**—The activities of this department are fully set forth by Curator Swarth. The number of accessions to the department has been large and valuable, the majority being from Alaska (Harrold and

Haley), Arizona (Swarth, Mailliard, and McLellan), and the valuable gifts by Mrs. Fanny Koebele and Mr. W. M. Giffard.

It is gratifying to know that Mr. Swarth has begun a study of the large collection of land birds obtained by the Academy’s Galapagos expedition of 1905-1906.

Department of Paleontology.—Valuable collections of Cretaceous and Jurassic fossils were obtained by Messrs. L. G. Hertlein and T. F. Stipp in eastern Mexico, and a large collection of Tertiary and Cretaceous Foraminifera was obtained in the same territory by Mr. C. M. Carson. Messrs. Hertlein and Emmet Rixford, Jr., spent some time on San Miguel, Santa Rosa, and Santa Cruz studying the geology and paleontology of those islands. They secured important collections for the department. These and the many other collections add greatly to the value of the department’s research material.

Considerable field work was done by Mr. Hertlein in the vicinity of San Diego, Banning and San Pedro. Dr. Hanna continued to add to the Academy’s collection of organic shales, which has now grown to considerable proportions.

Publications by the Museum Staff in 1927

The following bibliography lists the papers published by members of the Museum and Aquarium staffs in 1927.

Clark, H. Walton.

Eastwood, Alice.

Evermann, Barton Warren.

Hanna, G. Dallas.


Hertlein, Leo George.

Mailliard, Joseph

McLellan, M. E.
Seale, Alvin.

Slevin, Joseph R.
1. An additional Record of the Leather-Back Turtle on the coast of
April 22, 1927.

Swarth, Harry S.
1. The Rufous-necked Sandpiper on St. Paul, Pribilof Islands. <Condor,
Vol. XXIX, No. 4, pp. 200-201, July 15, 1927.
XXIX, No. 4, p. 205, July 15, 1927.
3. The Rufous-necked Sandpiper in Alaska. <Condor, Vol. XXIX,
No. 6, p. 274, November 15, 1927.

Van Duzee, Edward P.
pp. 139-142, April, 1927.
4. The Funkhouser Catalogue of Membracidae. <Pan-Pacific Ento-
5. On the Standing of the Genus Tibicen Latr. <Pan-Pacific Ento-

Acknowledgments

As in the past, many courtesies of one kind or another have
been shown the Academy by many individuals and by various
institutions. Although space does not permit specific mention
of all, the Academy is grateful to everyone who has shown
interest in its work and who has contributed in any way to
its success.

First of all must be mentioned those who have contributed
to the educational program of the Academy by giving one or
more lectures in our Sunday afternoon and Wednesday even-
ing lecture courses. The Academy's grateful thanks are also
due to each of those who have donated specimens or books to
the Museum or the Aquarium.
The Southern Pacific Company, the Atchison, Topeka, and Santa Fe Railway System, the Matson Navigation Company, and the Los Angeles Steamship Company, have each continued to take a deep interest in the scientific and educational activities of the Academy. Each of these great companies has extended many courtesies to the Academy and to members of its staff in connection with the field work of the Museum and the Aquarium. As a result of their cooperation the Academy’s exhibits and its research work on the Coast have been greatly advanced and the Museum’s study collections materially increased. The exhibits of tropical and southern California fishes have been maintained in excellent condition through the kindly cooperation of the Matson Navigation Company and the Los Angeles Steamship Company.

The Academy is under great obligation to Captain G. Allan Hancock of Los Angeles for his kindness in permitting Mr. Joseph R. Slevin and Mr. Frank Tose of the Museum staff to make a trip to the Galapagos Islands as his guests on the Oaxaca, thus affording them the opportunity to secure many valuable specimens for the Museum and the Aquarium.

The Academy’s thanks are also due Mr. L. M. Klauber of San Diego, for many courtesies extended to the Department of Herpetology.

**Department Reports**

**Department of Botany**

The Herbarium now numbers 151,501 sheets of mounted specimens, an increase of 7,935 during the year. There are, besides, many duplicates, and the entire collection from the Revillagigedo Islands which is still in the possession of the collector, H. N. Mason, whose report has not yet been submitted. The other specimens from the Academy’s 1925 Expedition have been determined by the curator with the exception of those from the Tres Marias Islands. A duplicate set of these was sent to the National Herbarium and the specimens were named by Dr. Paul C. Standley, an authority on Mexican plants. He also verified my determinations and the lists are now ready for publication.

Several short excursions were made by the curator. As the guest of Mrs. Charles Derby of San Jose, collections were made about Pacheco Pass and Los Baños.

A walking trip was made in Eldorado County from Placerville to Georgetown via Coloma and back via Kelsey. One day was spent at Winters, Yuba County, and one day at Byron Springs. Two short trips were made to San
Luis Obispo County and exploration was made possible over a great part of the county through the help of Mr. Irving Sinsheimer and Miss Gertrude Sinsheimer. One week was spent near Greenville, Plumas County, as the guest of Mr. and Mrs. Harry West of Forest Lodge. On the trip to Reno to attend the meeting of the Pacific Division of the American Association for the Advancement of Science, excursions were made to Pyramid Lake, Virginia City and Carson; also to the Plumas Forest Reserve via Chilcoot Pass. The hospitality and help which the members of the faculty of the University of Nevada gave is gratefully acknowledged.

Professor George Haley made further explorations in Alaska, collecting specimens in many places where the vessel stopped. On Nunivak Island where his stay was short his collection was supplemented by 74 specimens obtained there by Mr. C. G. Harrold. The total number of specimens obtained was over 300. The Academy now has an excellent representation of Alaskan and Arctic plants. Mr. Haley also collected in Nevada and Sierra counties, California, and donated a collection of about 100 specimens to the herbarium.

The Academy’s expedition of 1925 to islands off the Mexican coast resulted in the addition of 65 species from Magdalena Bay, 19 from San Quintin Bay, 24 from Turtle Bay, 13 from San Martin Island, 63 from Cedros Island, 45 from Guadalupe Island, 16 from Cape San Lucas and 120 from Tres Marias Islands. Duplicates of these have been distributed to the leading botanical centers and some are still on hand. Eight genera and 98 species were added, many of them being topotypes.

The following collections were received in exchange: 75 New England plants from the Gray Herbarium, Cambridge, Mass.; 163 Asia Minor plants from the University of Asiae Mediae, Tashkent, Turkestan, adding 15 genera and 131 species; 805 duplicates from the Jones Herbarium sent from Pomona College, Claremont, Calif., adding 80 species and several genera; 139 ferns and fern allies from the National Herbarium, Washington, D. C.; 13 Nebraska plants from Dr. H. Hapeman, all new to our herbarium.

The following collections were sent to correspondents in exchange: 25 to Dr. H. Hapeman; 365 to the U. S. National Herbarium; 319 to the Royal Herbarium, Kew, England; 184 to the Gray Herbarium; 300 to the University of Asiae Mediae; 184 to Pomona College; 52 woody plants to the Arnold Arboretum, Jamaica Plain, Mass.; 52 to Dr. S. F. Blake, Bureau of Plant Industry, Washington, D. C.

The following collections were purchased: 311 mosses from A. J. Grout, adding 5 genera and 58 species; 49 lichens from G. S. Merrill; 471 Chilian plants from D. E. Werdermann, adding 18 genera and 259 species. Some of these are not yet named, so the number of additions will be increased; 200 Mexican plants from Mrs. Ines Mexia, adding 7 genera and 90 species; 1,187 from Professor L. F. Henderson collected in eastern Oregon, many of which have not yet been named; 629 tropical African plants, the Zenker collection from the Kamerun District. This was purchased from Dr. Harold St. John, Pullman, Wash. There were about 500 duplicates in this collection which will be used for exchange. This added 180 genera, 562 species and 2 families; 240 from J. Aug. Kusche collected in the mountains near Douglas, Arizona. This collection contained many duplicates and was determined by the curator. It added several species, some of which may be new.

May 22, 1928
Mr. Eric Walther has contributed 130 exotics and a large collection from southern California which is still unlabelled. Small collections have come from many correspondents whose names will appear in the list of donors.

Two bequests have come during the year to the library of the Botanical Department. The most important is a portion of the valuable botanical library of the late Wm. F. Herrin, and the other a book of paintings of California wild flowers by Addie L. Harris, bequeathed to the Academy by the artist. The California Botanical Club has given 200 water-color pictures of California wild flowers, painted by Sophie H. Fauntleroy. These will eventually be placed in the Herbarium each with the species depicted.

The curator continues to give addresses to schools and clubs on various botanical subjects and has done much to establish a garden of Shakespeare's flowers in Golden Gate Park through the Spring Blossom and Wild Flower Association. The annual flower show of this association is also an important and popular duty. The California Botanical Club numbers 83 members and a meeting is held or an excursion made almost every week. A class of Golden Gate Park gardeners meets bimonthly in the evening in the Herbarium to enable the ambitious gardeners to learn the names of the plants in the park.

The flower show in the vestibule of the Museum is kept up throughout the year. Hundreds of species both native and cultivated are shown, labelled with name and where found native. This is one of the most popular features in the Museum and has incited similar exhibitions in other places, notably in the Natural History Museum at Santa Barbara and the Museum at San Diego.

My assistant, Mrs. George H. Phelps, besides taking all the responsibility of this exhibition has most efficiently done the mounting of the specimens, distributing them into the Herbarium, attending to the drying and pressing of the fresh specimens that are constantly coming in, and in many ways, taking much detail herbarium work from the curator.

Alice Eastwood, Curator.

Department of Entomology

The work in the Department of Entomology during 1927 was largely that of assimilation. The increase of the collection through field work and donations by friends of the Academy was about normal, and one considerable collection of beetles was presented to the Department. But the work of labelling and incorporating the Van Dyke, Koebele, and other collections recently received, has, perhaps, been the most prominent single feature of our work.

In February Mr. Louis S. Slevin of Carmel presented to the Academy his collection of Coleoptera with about the same conditions under which the Van Dyke and Blaisdell collections were accepted, and the work of labelling and incorporating it is being carried along in connection with similar work on the other collections mentioned. Mr. Slevin's collection was formed in Monterey County, especially about Carmel, and is the result of careful systematic collecting of the species peculiar to that locality and of judicious exchanging with eastern collectors. It contains series of many rare species that were scarcely represented otherwise in our collection.

The work of rearranging our collection of Coleoptera is progressing satisfactorily. Already 84,000 specimens of beetles from the Van Dyke collection
have been incorporated into that of the Academy by Mr. J. O. Martin, and these have been, or are being, carefully checked over by Dr. Van Dyke. The beetles from the Koebele and Slevin collections are being run in at the same time with the Van Dyke material. So far 23,000 specimens from the Koebele collection have been incorporated with the Academy series, the most of which were beetles. The Blaisdell collection of Coleoptera is now safely stored in the Department laboratory and Dr. Blaisdell expects very soon to begin the work of incorporating these into the newly arranged Academy collection.

During 1927 the Curator has found time to rearrange a few more families of the Hemiptera, incorporating 14,000 specimens from his own material into that of the Academy. He has also continued the rearrangement of the moths in the Academy collection including those from the Koebele collection. These, with those presented to us by Dr. Barnes of Decatur, Illinois, make our collection fairly representative of the North American fauna in this interesting group of insects.

The additions to the Department of Entomology during 1927, other than those from the Slevin Collection, number 20,718 specimens. Of these additions the larger lots include the following: Curator's field work at Truckee and Reno, 5139 specimens; Mr. J. O. Martin's field work in a trip to Texas, 4865 specimens; Dr. E. C. Van Dyke's Oregon trip, 1570, and from shorter collecting trips 691 specimens. These Van Dyke lots do not include the Coleoptera taken by him which are counted in the Van Dyke collection. Mr. H. H. Keifer's field work about Oroville and elsewhere in California, 2275 specimens; purchased from Mrs. Dora Wright, 1426 insects from French Indo-China; purchased from J. A. Kusche, 1364 moths from the Chiricahua Mountains, Arizona; presented by Mr. L. S. Slevin, 1356 moths taken at Carmel not included in the Slevin collection of Coleoptera; from Mr. J. O. Martin, 722 insects from California; from Dr. E. H. Nast, 488 insects from California and Oregon; by exchange from Dr. H. H. Knight of Ames, Iowa, 388 paratypes of the hemipterous family Miridae, representing 200 species described by him; from Mr. W. M. Giffard of Honolulu, 321 determined Hymenoptera from the Sierra Nevada; and from Dr. Wm. Barnes of Decatur, Illinois, 1000 moths to fill vacancies in our collection. Valuable and interesting material was also received from the following: Mr. E. R. Leach, Miss Annette Braun of Cincinnati, Mr. C. L. Hill, Mr. J. E. Cottle, Dr. W. S. Blatchley of Indianapolis, Dr. G. Dallas Hanna, Mr. F. H. Wymore, Mr. O. C. Poling, Mr. J. D. Gunder of Pasadena and Miss Mary E. McLellan of the Academy.

The publication of the Pan-Pacific Entomologist has been continued through the year. As stated last year this periodical furnishes an outlet for some of the shorter papers dealing with the Academy material. Fourteen such papers were published in the four numbers for 1927. These fill 63 pages and include descriptions of 39 new species, the types of which are in the Academy collection.

Again we wish to emphasize the pressing need of more room for the Department of Entomology. It looks as though another year would see about the last available space occupied. The Academy has accepted these large and valuable collections and is in duty bound to furnish suitable accommodations for their housing and arrangement. The west coast is on but the threshold of its development, in science as well as in industry. Some day it will have a great museum of natural history comparable to those in the east, and if the California
Academy of Sciences does not improve its opportunity and build up such a museum some other institution will. This Academy has already laid a splendid foundation for such a museum, but it is only a foundation and it should not rest content with what it has accomplished but must press forward and take full advantage of the opening it has made. Most important just now is a new research building to furnish space for the development of certain of the departments now badly overcrowded. Then there should be more help provided for the care and development of the great mass of material acquired.

This Academy has assumed the leadership in this work here on the coast. We must now push forward or we will slip backward; we cannot remain stationary. We must embrace the unique opportunity now open to us or we will lose it. Our entomologists here have supported this department most valiantly but they will not continue their support if we do not do our part in properly caring for the valuable material they have given their time and money to secure for us.

E. P. Van Duzee, Curator.

Department of Exhibits

The Department of Exhibits reports satisfactory progress during the year. With the completion of four more panel groups all available spaces in the Bird and Mammal Halls are filled.

These groups are: California Pocket Gopher and California Mole; Tejon Bat; Pacific Pallid and Mexican Free-tailed Bat; California Grey Squirrel; and Gila Woodpecker.

In September it was decided to participate in the Pacific Foreign Trade and Travel Exposition, to be held in the Civic Auditorium, San Francisco.

Under the direction of Mr. Joseph R. Slevin, Assistant Curator of Herpetology, and with his help and that of my assistants, eleven groups of reptiles were constructed, completed and installed by the opening day, November 11, 1927.

These groups were: Giant Galapagos Land Tortoises, Red Diamond Rattlesnake, Chuckwalla, Boyle’s Milk Snake, Western Collared Lizard, Horned Rattlesnake, Marbled Salamander, Northern Crested Lizard, Leopard Lizard, Tricolor Ground Snake, Desert Gridiron-tailed Lizard.

In addition, 11 species of California fungi, modeled in wax, were exhibited in two groups, also four portable school groups, two of which were constructed especially for this exhibit. The exhibit received very favorable comment and fulfilled the twofold purpose of advertising the Academy’s activities and suggesting what might be accomplished in a Reptile Hall, in Botanical Exhibits, and School Extension work.

The total number of habitat groups completed during the year was 19. In addition much work was accomplished for the Department of Ornithology and Mammalogy, including the cleaning of a large number of skulls and skeletons which had accumulated over a period of years, tanning a quantity of hides, and making over 100 large bird skins from salted specimens.

A considerable number of wax models of flowers, fruits, and fungi were made for a future botanical exhibit. This amount of work was made possible by the
employment, during the greater part of the year, of Miss Clara Tose, as assistant in accessories and Russell Hendrick as general assistant. Cecil Tose also rendered assistance at various times. They have all done excellent work.

Three expeditions were undertaken during the year, as follows: April 27 to June 7, in San Diego County, with Mr. Joseph R. Slevin. Specimens were collected and sketches made for many of the reptile groups exhibited later in the year. Considerable material was collected for school groups and for additions to the Desert Bird Group.

June 25 and 26, to Cloverdale, Sonoma County, for the purpose of securing material for a group of Bats.

November 15, 1927, to January 7, 1928, as a guest of Captain G. Allan Hancock, to the Galapagos Islands. Accessory material was secured for a Gigantic Tortoise Group, and complete material and sketches for groups of Sea and Land Iguanas of the Galapagos Islands, and the Rock Iguana of the Tres Marias.

FRANK TOSE, Chief.

Department of Fishes

This department is being built up for the mutual interest and benefit of the Museum and the Aquarium. From time to time interesting specimens die in the Aquarium and it is the policy to save such specimens to put in a reference collection or for special study. Our collectors in the field often secure duplicate specimens that are of value for anatomical studies or for exchange. Some of the expeditions which the Museum sends out make considerable collections of the fishes of the region visited and these are cared for by this department. We are in these various ways gradually building up an extensive reference collection of fishes, particularly of the freshwater and salt water species of California and of the Hawaiian fish fauna, which will supplement the live exhibits in the Aquarium. In time we hope to have in this Reference Collection, at least one good specimen of every species of fish known to occur in Western America (particularly in California), and in the Hawaiian Islands.

H. WALTON CLARK, Assistant Curator.

Department of Herpetology

During the year 1927, in the regular work of classification, special attention was paid to the collection of Amphibians, and 1106 specimens were permanently installed. In addition to this 1723 specimens from various accessions were recorded, labeled, and card-catalogued.

There have been added to the collection during the year 806 specimens so that it has now grown to 62,556 specimens.

Gifts of specimens have been received as follows: From Mrs. C. W. Campbell, 2; L. M. Klauber, 152; W. M. Mann, 2; Dr. G. Dallas Hanna, 1; F. M. Anderson, 2; L. S. Slevin, 3; J. O. Martin, 3; A. M. Woodbury, 12; Frank Arundel, 5; Steinhart Aquarium, 20; Dr. E. C. Van Dyke, 10; E. R. Leach, 2; J. W. Mailliard, 1; Don C. Meadows, 2; and C. S. Bishop, 2.
Specimens have been secured from 10 counties of California as follows: Alameda, 2; Kern, 3; Los Angeles 2; Marin, 2; Mendocino, 1; Monterey, 3; Napa, 20; San Diego, 551; Shasta, 1; and Ventura, 5.

Specimens from other localities are: Arizona, 8; Florida, 15; Idaho, 5; Kansas, 18; Michigan, 2; New York, 2; Oregon, 3; Utah, 12; Africa, 3; Costa Rica, 1; Dominica, 1; Ecuador, 1; Jamaica, 4; Mexico, 2; Nicaragua, 8; and Porto Rico, 6.

In conjunction with the Department of Exhibits an expedition was made in April and May to San Diego County, California, for the purpose of securing some of the rare burrowing snakes inhabiting that region. The collection of 401 specimens made on this expedition includes a series of the Tricolor Ground Snake, one of the rarest of Californian snakes, and a specimen of the Leaf-nosed Snake, the fourth taken in California.

Through the courtesy of Captain G. Allan Hancock of Los Angeles, a second expedition was made to the Galapagos Islands. This expedition was made for the express purpose of collecting specimens of the Land and Sea Iguanas peculiar to the Galapagos for the making of habitat groups, and included stops at Cocos, Malpelo, Isabel, and the Tres Mariettas islands. Captain Hancock afforded every opportunity to carry on the work, and through his kindness and enthusiasm, all the necessary specimens and accessories were secured. The stop at Malpelo Island resulted in securing an excellent series of lizards not heretofore represented in the collection.

An account of the Amphibians of Western North America, intended as a companion volume to the work already published on the Reptiles has been presented for publication.

Joseph R. Slevin, Assistant Curator.

Library

Total accessions to the Library during 1927 numbered 9809 items, of which 2447 were complete volumes, 7243 were pamphlets, and 119 were maps. Of the complete volumes, 241 were received as gifts, 1205 by exchange, and 1001 by purchase. These figures show a considerable gain over those for 1926, and compare favorably with figures given by some of the great natural history libraries of the eastern states. An important part of the botanical library of the late William F. Herrin was bequeathed to the Academy and it is expected that this very important acquisition will be incorporated in the Library during 1928. The Koebele gift, chiefly entomological, also represents an important addition; these books are not included in the figures given above, as they are still in process of being listed and filed.

New exchanges during 1927 numbered 33. This number represents only a few of the institutions which are not as yet on the Academy's list, and whose publications are needed here.

Early in 1927 it became the custom to keep the Library open during Saturday afternoon and already this has proved a step in the right direction. Members have come in who would not have been able to visit the Library at other times; and students from the University of California and Stanford University have discovered opportunities to use the Academy's Library on Saturday afternoons, and have expressed their appreciation.
The Library is becoming crowded for space. The large collection of duplicates is now in such order that much of it can be disposed of, by sale or exchange, as such transactions may be authorized, and additional room can thus be made available. Irrelevant material not incorporated in the Library but occupying shelf-space offers a serious difficulty, and must somehow be disposed of, not only to make space but also to render these valuable books available to readers who will not readily find them here.

Comparatively little binding was done in 1927, as the Library fund was called upon to provide for extensive purchasing. It is hoped that more binding will be done in the present year.

The catalogue remains seriously in arrears, although the libraries in the departments of Botany and Herpetology have been catalogued to some extent during the past year. In the Department of Herpetology, Miss Hicks has bound and catalogued a large collection of separates and other pamphlets, so that this department library is now in better condition than the others. Miss Arnold has succeeded in bringing up to date an author analysis of a few of the more important serials, and Library of Congress cards have been ordered for future issues. By the end of 1928 it is hoped to have completed the author analysis of the most important serials, and to have Library of Congress cards for such as are so catalogued. The subject catalogue can then be carried forward to cover such serials, insofar as printed cards are not available.

Care of the reserve stock of Academy publications, filling of orders, and distribution of new issues, constitute a large portion of the library work. The reserve stock of some of our publications is unnecessarily large. Certain publications, such as Occasional Paper No. 10, and some of the geological papers, can be sold to a considerable extent if properly circularized, if one may judge from the present sale without advertising. It is hoped that some progress in this direction may be made during 1928, not only to make space and to increase circulation of the Academy's publications, but also to add to the income.

Mr. Raymond Smith has continued to assist in the distribution of publications.

I. M'Guire, Assistant Librarian.

Department of Ornithology and Mammalogy

The present curator took charge of the department on March 1, coincident with the retirement of Mr. Joseph Mailliard as curator emeritus. This change did not involve any alteration in departmental policies or lines of work; current activities have been of about the same nature as before.

Circumstances permitted the prosecution of rather more field work than has been done for several years. The most important of this work was carried on by Mr. C. G. Harrold, of Winnipeg, Manitoba, who accompanied Professor George Haley, of San Francisco, on a trip to Alaska. Several of the Academy's departments were interested in this expedition, but Mr. Harrold's time was devoted almost entirely to birds and mammals (especially birds) and an important collection was made. He was gone from May 10 to November 6. He visited Sitkalidak, Unalaska, Akutan, and Nunivak islands, but the bulk of the collecting
and the most important observations were made upon Nunivak. This large island had not previously been visited by an ornithologist and the resulting collection of birds is of prime importance. It will form the basis of a published report later on. Included therein are at least two species that are new to the North American avifauna, and there are also certain rare species represented by series of specimens that will repay study from various angles. Mr. Harrold donated his services, his actual expenses being the only cost to the Academy. The success of his labors (under extremely trying conditions) can hardly be over-emphasized; it is doubtful if any other single individual, in the same length of time, has brought out of Alaska as many and as beautifully prepared bird specimens. Mr. Harrold's field notes, too, will add greatly to any published account of this collection.

Field work was carried on in southeastern Arizona during much of the summer. The region explored comprised the lowlands surrounding the Santa Rita Mountains, southeast of Tucson and a few miles north of the United States-Mexico boundary. There is a problem in animal distribution presented in this particular section that had attracted the writer's attention years ago, and advantage was taken of the opportunity for further investigations there at this time. Work was carried on as follows: By Messrs. H. S. Swarth and J. Mailliard, with Raymond Gilmore as assistant, and D. M. Gorsuch of Tucson, as volunteer aid during most of the time, from May 6 to June 25. Half of this time was spent near Patagonia, on the east side of the Santa Ritas, and half at the Florida Ranger Station on the west side; by J. Mailliard, with Floyd Rankin as assistant, August 23 to October 17, near Patagonia; and by Miss Mary E. McLellan, September 1 to October 13, in Madera Cañon, on the west side of the Santa Ritas.

Departmental work of the sort that is necessary to the proper care of the collections has taken, and will take, a large part of the time of the department's staff. The identifying, cataloguing and installing of the year's accessions is by itself a big undertaking, and the crowded condition of the general collection makes such work more difficult. Five storage cases were purchased at the end of the year, some of which may be used to relieve the congestion in parts of the collection. All of the cataloguing and the bulk of the other curatorial drudgery has fallen upon Miss McLellan. Mr. Mailliard since his retirement has spent much of his time at the Museum upon the proper arrangement of the Mailliard collection of birds and eggs, and he has also helped at various times at curatorial work in the general collection.

Several studies are under way of material in the bird and mammal collections. The writer is engaged upon a report covering the work that was done in Arizona. He has also begun a study of the enormous series of land birds of the Galapagos Islands in the collection, gathered upon the Academy expedition to those islands in 1905-1906. These birds, comprising one of the most important collections ever made on the Galapagos, have not yet been identified and studied, and this work will be pushed to completion as rapidly as circumstances permit. Miss McLellan has nearly completed a paper on the distribution of the wedge-tailed shearwater, and, in collaboration with Dr. G. Dallas Hanna, has finished a paper entitled "Skull characters of the Alaska fur seal." She is now engaged in a study of certain osteological features of the northern elephant seal.
It is a satisfaction to report that the bird collection of the Academy is of sufficient importance to have attracted the attention of various visiting ornithologists of international renown. During the past year some of our distinguished visitors from a distance were Mr. Gregory M. Mathews, England, Mr. Jean Delacour, France, Mr. Masa U. Hachisuka, Japan, Dr. T. Gilbert Pearson, President of the National Association of Audubon Societies, Mr. P. A. Taverner, Ottawa, Canada, and Dr. T. S. Palmer, United States Biological Survey.

This department has had occasion to call upon other institutions for information and for the loan of specimens, and, similarly, we have occasionally been able to assist others in their studies. Dr. E. W. Nelson and Major E. A. Goldman, of the United States Biological Survey, spent several days at the Academy examining birds and mammals from Mexico in our collection, and they subsequently borrowed many of these specimens to be forwarded to Washington for further study.

During 1927 there were added to the collection: birds, 1858; mammals, 519. The specimens are mostly the usual "study skin" of bird, and "study skin," plus skull, of mammal, but there are a few bird skeletons entire, and a few mammal skulls without accompanying skins. Most of this material came from the above described field trips, as follows: C. G. Harrold, Alaska, 555 bird skins, 10 bird skeletons, 74 mammals, 12 sets of birds' eggs. Swarth, Mailliard, Gorme, and Gorsuch, Arizona, 429 birds, 321 mammals, 10 sets of birds' eggs. Mailliard and Rankin, Arizona, 424 birds, 10 mammals. Miss McLellan, Arizona, 274 birds, 92 mammals.

Other accessions are as follows: Birds. Gift: Dr. Frank E. Blaisdell, 14; Mr. A. W. Robison, 9; Mr. E. W. Gifford, 1; Mr. Morris Green, 1; Mr. T. Mori, 6; Mr. Trygve Ronneberg, 3; Mr. W. C. Lewis, 1; Mr. A. C. Griffith, 1; Mr. Perc Meakin, 1; Mrs. Fanny Koebele, 44; California Fish and Game Commission, 3; Mr. John McLaren, 2; Miss Kruger, 2; Mr. J. W. Steinbeck, 1; Mr. W. M. Giffard, 28; Mr. A. C. Montgomery, 6; Mrs. A. C. Sulkamp, 3; Mr. J. O. Martin, 1; Mrs. W. M. Willett, 2; Mr. Frank A. Leach, 1. Purchase: Mr. J. T. Wright, 36.

Eggs. Gift: Capt. H. W. Rhodes, 41; Mr. John W. Classen, 1; Dr. G. Dallas Hanna, 2.

Mammals. Gift: Mrs. Paul Paige, 1; Mr. and Mrs. Harry Archambault, 1; Mr. Jack Solini, 1; Mr. John McLaren, 2; Mr. Frank A. Leach, 1; Mrs. Constance Campbell, 1; Dr. Frank E. Blaisdell, 6; Mr. A. W. Robison, 1; Steinhart Aquarium, 1; Mr. H. W. Clark, 1; Miss Mary Elizabeth Reed, 1; Mr. A. Holm, 1; Mr. Peterson, 1. Purchase: Mr. J. T. Wright, 3.

Harry S. Swarth, Curator.

Department of Paleontology

Valuable material from several well selected localities was added to the collection of the Department of Paleontology during 1927. The available storage space allotted to the department has now become so restricted that general duplication of collections must be curtailed and the normal growth of the research collection must follow a limited and well considered plan. Long again this situation was anticipated and such collections as were not most often
consulted were stored in the basement of the Museum in such a manner as to permit their being as accessible as possible in such a situation. The basement is poorly lighted and ventilated and was never intended to be put to such use when the building was designed; it can only be used for this purpose as a temporary expedient until better facilities are available but already at least half of the bulk of the department’s collection is stored there.

A valuable collection of Cretaceous and Jurassic fossils was obtained in eastern Mexico through the efforts of Messrs. L. G. Hertlein and T. F. Stipp; this material is necessary for comparison with our western fossils of equivalent age. Also, a large collection of Tertiary and Cretaceous Foraminifera was obtained in the same territory by Mr. C. M. Carson.

An excellent collection of Cretaceous fossils was obtained in Butte County, California, at one of the collecting stations of the old California Geological Survey.

Pliocene material was obtained in the vicinity of Banning and San Diego to supplement collections already made. For the same purpose some work was done in the Pleistocene at San Pedro.

Probably the most noteworthy collection added to the department during 1927 was that made by Messrs. Hertlein and Rixford on San Miguel, Santa Rosa and Santa Cruz islands. A very considerable collection of well-selected fossils from the Miocene was obtained on these islands and much data on the geology was secured. Also many land and marine shells and samples of diatomaceous shales were brought back.

Messrs. George Haley and C. G. Harrold obtained some excellent recent shells during their field work in Alaska.

The Curator continued to add to the collection of organic shells. The samples retained were chosen primarily because of their containing well-preserved diatoms, foraminifera, radiolarians, ostracods or silicoflagellates.

A large collection of recent land and freshwater shells from China was purchased from Mr. and Mrs. John T. Wright. The collection is being studied by Dr. Bryant Walker who shared in the expense of purchase.

Dr. Barton Warren Evermann and the Curator obtained a most unusual assemblage of living diatoms from Pyramid Lake, Nevada. It is expected that a study of these organisms will shed some light on the origin and history of this interesting body of water.

The arrangement of the collections in the Museum is considered to be regular routine work and calls for no special mention except in regard to the collection of type specimens. All type material in the custody of the department is segregated from the general collection and separately catalogued. This type collection now numbers more than 3,000 specimens and the records respecting each one are kept strictly up to date. A study as broad as paleontology, embracing as it does the entire organic world, necessarily requires that such a collection of types be systematically arranged. That the methods adopted by the department are highly satisfactory is best shown by the very complimentary comments of officials in charge of similar institutions elsewhere.

Late in 1926, as mentioned in the report for that year, there was announced the discovery of a synthetic resin suitable for mounting microscopic objects. It was later shown that this resin increased the visibility of an object mounted
therein. 450 percent over the visibility of the same object in Canada balsam, the usual mountant. It may now be recorded that this resin has proved to be chemically stable, easily manipulated, and optically superior to any hitherto known mounting medium. The discovery of this material, called “A. F. S.”, was the incentive for further research with synthetic resins and it is now fitting to announce that two of these interesting substances made of (1) thiocarbanilide, trioxymethylene and iodine, and (2) naphthalene and formaldehyde, have properties which would seem to make them valuable in increasing the visibility of microscopic objects. Both of these resins require observation for several months more in order to determine their chemical stability but it is not likely that they will prove disappointing.

Paleontology is such a broad branch of science that the literature on the subject is very voluminous and widely scattered. However, without a considerable proportion of this literature available for consultation no serious research can be attempted and no results can be obtained which are likely to be of more than extreme local interest. Additions to the library in 1927 pertaining to geology and paleontology have been the most important and satisfactory for many years; this has been due to the efforts of our Librarian, Mr. Ignatius M'Guire. It is believed that the continued acquisition of such specialized literature in the future is most important and it is hoped that the beginning which has been made may be continued.

Outstanding loans from the collections in the custody of the department at the end of the year were charged to the following persons: Dr. Paul Bartsch, U. S. National Museum; Dr. Remington Kellogg, Carnegie Institution; Dr. S. S. Berry, Redlands, Calif.; Dr. Fred Baker, Point Loma, Calif.; Mr. A. M. Strong, Los Angeles, Calif.; Dr. Bryant Walker, Detroit, Mich.; Dr. Junius Henderson, University of Colorado; Dr. Albert Mann, Carnegie Institution.

The efficient and faithful assistance rendered by the assistants in the department, Mr. Leo George Hertlein, Assistant Curator and Mr. Emmet Rixford Jr., temporary assistant, is acknowledged with much pleasure. Also Mr. Frank M. Anderson has given his time unstintingly in the identification and arrangement of the collections and, as usual, he has contributed many fossils of lasting value to the Academy's collection.

G. Dallas Hanna, Curator.

Steinhart Aquarium

On September 29, 1927, the Steinhart Aquarium passed its fourth anniversary. It is a pleasure to record that the Aquarium still remains among the most popular public institutions in San Francisco.

The total number of live specimens of all kinds in the tanks December 31, 1927, was 8754, representing 370 different species, an increase of 658 specimens and 69 species over last year. At the same time, there has been a most satisfactory decrease of 272 specimens in the mortality list.

The different branches of the animal kingdom are represented in the following numbers:
Mammals........ 11 specimens of........ 5 species
Birds............ 3 specimens of........ 2 species
Reptiles........ 136 specimens of........ 35 species
Batrachians...... 41 specimens of........ 6 species
Fishes........... 8241 specimens of........ 256 species
Invertebrates.... 322 specimens of........ 6 species

Total...........8754  310

The above is exclusive of the numerous young trout and salmon in the hatchery, where several thousand young fish have been hatched during the year.

Friends of the Aquarium have been very generous during the past year, 2170 donations having been received since December, 1926. Among these gifts were eight alligators and two crocodiles, two seals and one California sea-lion. A detailed list with the names of the donors will be found in the appendix. This number is exclusive of several thousand Mosquito fish given us by the State Board of Health for free distribution, and of 1473 specimens of fishes and plants bred or grown in the Aquarium greenhouse. During this period the exchange and gifts from the Aquarium numbered 1452.

One of the most interesting exhibits shown during the past year was four Porpoises. Owing, however, to the poor condition of the water these lived only six weeks.

Through the kindness of the Matson Navigation Company we received on November 24 the first tropical fishes from Pago Pago, Samoa, that have ever been shown in the United States. These are brilliantly colored reef-fishes considerably brighter than any of the Hawaiian fishes. Eighty-eight specimens representing 23 species have been received from those distant islands.

For the most part the specimens on exhibition are healthy and contented. This was well illustrated by the Golden Trout, which made their nest, spawned, and hatched their young in Tank 32. These young fish were transferred to the hatchery and have now reached the fingerling stage. They have passed most of the dangers common to the early life of fishes. This is the first time these fish have ever been known to breed in captivity.

During the past year the total number of fishes raised in the Aquarium greenhouse and distributed to the exhibition tanks was 709 specimens of 27 species. In addition there were 1218 aquatic plants grown and distributed. There now remains (as per invoice of September 30, 1927) in the greenhouse 618 fishes distributed in 73 breeding aquariums.

A small number of useful books has been added to the library during the year.

In the Laboratory the Aquarium Society has held regular meetings each month, usually with an exhibition of fishes and lectures on aquarium subjects.

Research work has been conducted in the laboratory on the nervous system of certain sharks by a graduate student, Miss Edith Stokes, of the University of California. Mr. Edward Jockey of the University of California also occupied one of the tables with research work during March and April.
During the past year President Grunsky of the California Academy of Sciences visited a number of the European aquariums and returned with some valuable suggestions for improvements at our institution. We hope that during the coming year a number of these suggestions, especially those relating to an increase in the invertebrate exhibits and the lining of additional tanks with attractive rock work, may be carried out.

Alvin Seale, Superintendent.

Gifts to Steinhart Aquarium in 1927

The accessions to the Steinhart Aquarium by donation or otherwise in the year have been many, as shown in the following itemized list.

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<th>Date</th>
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<td>9</td>
<td>Carassius auratus</td>
<td>A. Sarnsen, San Francisco, Calif.</td>
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<td>Diacanthiodon ensatia</td>
<td>A. Sarnsen, San Francisco, Calif.</td>
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<td>Gambusia affinis</td>
<td>California State Board of Health.</td>
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<td>Trout and salmon Eggs</td>
<td>California State Fish and Game Comm.</td>
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<td>13</td>
<td>Lebistes reticulatus</td>
<td>H. Walton Clark, San Francisco, Calif.</td>
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<td>13</td>
<td>Acipenser transmontanus</td>
<td>Luigi Cosignany, Collinsville, Calif.</td>
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<td>Feb.</td>
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<td>Starfish</td>
<td>Edmond Conasay, San Francisco, Calif.</td>
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<td>Sea Cradles</td>
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<td>Salamander Eggs</td>
<td>Edmond Conasay, San Francisco, Calif.</td>
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<td></td>
<td>4</td>
<td>Platypoecilus auratus</td>
<td>Alvin Seale, San Francisco, Calif.</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Chrysemys elegans</td>
<td>Russel Warren Welch, San Francisco, Calif.</td>
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<tr>
<td></td>
<td>22</td>
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<td>Mrs. M. Nicolai, San Francisco, Calif.</td>
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<tr>
<td>Mar.</td>
<td>2</td>
<td>Platypoecilus immaculatus</td>
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<tr>
<td></td>
<td>14</td>
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<td>Mrs. E. P. Van Duzee, Alameda, Calif.</td>
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<tr>
<td></td>
<td>16</td>
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<td>William Cronan, San Francisco, Calif.</td>
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<tr>
<td></td>
<td>18</td>
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<td>Masters Jack and Harry Powell, San Francisco, Calif.</td>
</tr>
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<td></td>
<td>22</td>
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<tr>
<td></td>
<td>22</td>
<td>Mollienisia latipinna</td>
<td>Alvin Seale, San Francisco, Calif.</td>
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<tr>
<td></td>
<td>28</td>
<td>Chrysemys elegans</td>
<td>Miss Wanda Berkovits, San Francisco, Calif.</td>
</tr>
<tr>
<td>April</td>
<td>2</td>
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<td>Alvin Seale, San Francisco, Calif.</td>
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<td>2</td>
<td>Chelopus marmoratus</td>
<td>Fred Fisher, San Francisco, Calif.</td>
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<td>Platypoecilus maculatus</td>
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<tr>
<td></td>
<td>8</td>
<td>Danio rerio</td>
<td>Frank Locke, San Francisco, Calif.</td>
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<tr>
<td></td>
<td>8</td>
<td>Limia arnoldi</td>
<td>Frank Locke, San Francisco, Calif.</td>
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<tr>
<td></td>
<td>8</td>
<td>Haplochilus chaperi</td>
<td>Frank Locke, San Francisco, Calif.</td>
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## Gifts to Steinhart Aquarium in 1927—Continued

<table>
<thead>
<tr>
<th>Date</th>
<th>No</th>
<th>Article</th>
<th>Donor</th>
</tr>
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<tbody>
<tr>
<td>April</td>
<td>8</td>
<td>Badis badis</td>
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<td>Molliesinia latipinna</td>
<td>Frank Locke, San Francisco, Calif.</td>
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<td>Cobitis fossilis</td>
<td>L. Kemiuli, San Francisco, Calif.</td>
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<td>Triturus torosus</td>
<td>L. Kemiuli, San Francisco, Calif.</td>
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<td>11</td>
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<td>H. Walton Clark, San Francisco, Calif.</td>
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<td>Aquatic Plants</td>
<td>H. Walton Clark, San Francisco, Calif.</td>
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<td>Phoca geronimensis</td>
<td>Alexander Paladini, San Francisco, Calif.</td>
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<td></td>
<td>20</td>
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<td>P. J. Odca, San Francisco, Calif.</td>
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<td>D. Carten, San Francisco, Calif.</td>
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<td>22</td>
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<tr>
<td></td>
<td>26</td>
<td>Carassius auratus</td>
<td>Bruce's Goldfish Hatchery, Thornburgh, Iowa</td>
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<td>Platypoecilus niger</td>
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<td>Xiphophorus ruber</td>
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<td></td>
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<td>Macropodus opercularis</td>
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<td>May</td>
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<td>Lychee Tree</td>
<td>G. W. Graff, Berkeley, Calif.</td>
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<td></td>
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<td>Lebistes reticulatus</td>
<td>H. Walton Clark, San Francisco, Calif.</td>
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<td></td>
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<td>Randallia ornata</td>
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<td></td>
<td>14</td>
<td>1 lot Eggs (Salmo irideus)</td>
<td>California State Fish and Game Commission.</td>
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<td>Mrs. H. Patten, San Francisco, Calif.</td>
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<tr>
<td></td>
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<td>Betta splendens</td>
<td>Dr. Hugh M. Smith, Bangkok, Siam.</td>
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<tr>
<td></td>
<td>25</td>
<td>Diemictylus pyrrhogaster</td>
<td>Mrs. E. J. Spears, San Francisco, Calif.</td>
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<td>Rana catesbiana</td>
<td>California State Fish and Game Commission.</td>
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<tr>
<td></td>
<td>2</td>
<td>Oryzias latipes</td>
<td>Alvin Seale, San Francisco, Calif.</td>
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<td></td>
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<td>Alligator mississippiensis</td>
<td>Mrs. S. J. Bettman, San Francisco, Calif.</td>
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<td>13</td>
<td>Chondrotus tenebrosus</td>
<td>W. H. Penniman, Santa Cruz, Calif.</td>
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<td></td>
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<td>Lebistes reticulatus</td>
<td>Clynt S. Martin, San Francisco, Calif.</td>
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<td>17</td>
<td>Xiphophorus helleri</td>
<td>Clynt S. Martin, San Francisco, Calif.</td>
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<td>Salmo henshawi</td>
<td>Washoe County Fish Hatchery, Reno, Nevada.</td>
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<td>July</td>
<td>3</td>
<td>Spatula clypeata</td>
<td>Paul Paige, San Francisco, Calif.</td>
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<td>Platypoecilus ruber</td>
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<td>Chelopus marmoratus</td>
<td>J. Wallenens, Berkeley, Calif.</td>
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<td></td>
<td>9</td>
<td>Molliesinia latipinna</td>
<td>Alvin Seale, San Francisco, Calif.</td>
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<td>Platypoecilus niger</td>
<td>Alvin Seale, San Francisco, Calif.</td>
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<td>18</td>
<td>Xiphophorus helleri</td>
<td>Alvin Seale, San Francisco, Calif.</td>
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<tr>
<td></td>
<td>18</td>
<td>Aquatic plants</td>
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<td></td>
<td>19</td>
<td>Chrysemys elegans</td>
<td>Elmer Coggins, San Francisco, Calif.</td>
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<td>Chelopus marmoratus</td>
<td>Miss Murial Fraser, Oakland, Calif.</td>
</tr>
</tbody>
</table>
Gifts to Steinhart Aquarium in 1927—Continued

<table>
<thead>
<tr>
<th>Date</th>
<th>No</th>
<th>Article</th>
<th>Donor</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>26</td>
<td>1 Iguana tuberculata</td>
<td>D. C. Panela, San Francisco, Calif.</td>
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<td>6 Haplochromis multicolor.</td>
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<td>27</td>
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<td>28</td>
<td>8 Xiphophorus ruber</td>
<td>Alvin Seale, San Francisco, Calif.</td>
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<td></td>
<td>28</td>
<td>1 Phoca geronimensis</td>
<td>International Fish Co., San Francisco, Calif.</td>
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<td>Aug.</td>
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<td>110 Aquatic plants</td>
<td>Alvin Seale, San Francisco, Calif.</td>
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<td>1 lot Gambusia affinis</td>
<td>California State Board of Health, Sacramento, Calif.</td>
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<td>5</td>
<td>6 Platypoecilus maculatus</td>
<td>Alvin Seale, San Francisco, Calif.</td>
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<td>1 Crocodileius americanus</td>
<td>F. M. Page, Richmond, Calif.</td>
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<td>17 Dallia pectoralis</td>
<td>W. A. Murry, San Francisco, Calif.</td>
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<td>175 Aquatic plants</td>
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<td>12 Macropodus opercularis</td>
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<td></td>
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<td>200 Aquatic plants</td>
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<tr>
<td></td>
<td>23</td>
<td>70 Tropical fishes</td>
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<tr>
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<td>26</td>
<td>200 Tropical fishes</td>
<td>Alvin Seale, San Francisco, Calif.</td>
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<tr>
<td></td>
<td>26</td>
<td>250 Tropical fishes</td>
<td>Alvin Seale, San Francisco, Calif.</td>
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<td>Miss Betty Hall, San Francisco, Calif.</td>
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<td></td>
<td>30</td>
<td>1 Chondrotus tenebrosus</td>
<td>J. Black, San Francisco, Calif.</td>
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<td>Sept.</td>
<td>1</td>
<td>1 Alligator mississippiensis.</td>
<td>B. G. Reynolds, San Jose, Calif.</td>
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<td>3</td>
<td>4 Xiphophorus ruber</td>
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<td>56 Agosia chryso gaster</td>
<td>Joseph Mailliard, San Francisco, Calif.</td>
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<td>88 Gillichthys mirabilis</td>
<td>Dr. A. E. Cerf, San Francisco, Calif.</td>
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<td>70 Tropical fishes</td>
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<tr>
<td></td>
<td>28</td>
<td>388 Aquatic plants</td>
<td>Alvin Seale, San Francisco, Calif.</td>
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<tr>
<td>Oct.</td>
<td>7</td>
<td>4 Cyprinodon macularius</td>
<td>Joseph Mailliard, San Francisco, Calif.</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>41 Agosia chryso gaster</td>
<td>Joseph Mailliard, San Francisco, Calif.</td>
</tr>
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<td></td>
<td>10</td>
<td>1 Tatusia novemcincta</td>
<td>Henry E. Elrod, San Benito, Texas.</td>
</tr>
<tr>
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<td>2 Gopherus berlandieri</td>
<td>Henry E. Elrod, San Benito, Texas.</td>
</tr>
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<td>25 Lebistes reticulatus</td>
<td>H. Walton Clark, San Francisco, Calif.</td>
</tr>
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<td></td>
<td>18</td>
<td>1 Chelonias agassizii</td>
<td>W. O. Flatter, San Francisco, Calif.</td>
</tr>
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<td>24</td>
<td>1 Alligator mississippiensis.</td>
<td>Mrs. G. Ball, San Francisco, Calif.</td>
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<tr>
<td></td>
<td>25</td>
<td>1 Alligator mississippiensis.</td>
<td>Mrs. C. Brennan, San Francisco, Calif.</td>
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<td></td>
<td>28</td>
<td>1 Anolis carolinesis</td>
<td>Mrs. J. Simpers, San Francisco, Calif.</td>
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<td>31</td>
<td>15 Small Snakes</td>
<td>A. Albers, San Francisco, Calif.</td>
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<td>Nov.</td>
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<td>7 Carassius auratus</td>
<td>Mrs. Eva Williams, Sacramento, Calif.</td>
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<td>36 Samoan fishes</td>
<td>C. J. Knudsen, San Francisco, Calif.</td>
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<td></td>
<td>22</td>
<td>1 Clemmys insculptus</td>
<td>Dr. S. C. Bishop, Albany, New York.</td>
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<td></td>
<td>25</td>
<td>12 Lebistes reticulatus</td>
<td>H. Walton Clark, San Francisco, Calif.</td>
</tr>
<tr>
<td>Dec.</td>
<td>9</td>
<td>1 lot Gambusia affinis</td>
<td>California State Board of Health, Sacramento, Calif.</td>
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<td>2 lots Trout and salmon Eggs</td>
<td>California State Fish and Game Commission.</td>
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<td>21</td>
<td>2 lots Gambusia affinis</td>
<td>California State Board of Health, Sacramento, Calif.</td>
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<td>26</td>
<td>1 lot Whitefish Eggs</td>
<td>United States Bureau of Fisheries, Washington.</td>
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</table>
# FINANCIAL STATEMENTS

## REPORT OF THE TREASURER

For the fiscal year ending December 31, 1927

January 1, 1927, Balance due Crocker First National Bank... $ 4,099.46

**Receipts:**

- Dues: $3,568.35
- Charles Crocker Scientific Fund Endowment Income: $1,703.88
- James Lick Endowment Income: $68,572.77
- General Income: $18,724.11
- John W. Hendrie Endowment Income: $960.00
- Publication: $315.30
- Interest: $1,012.90
- Ignatz Steinhart Trust Interest: $600.02
- Post Card Sales: $1,139.37
- Bills Receivable: $9,000.00
- W. G. Wright Fund: $3.50

**Total Receipts:** $105,600.20

**Balance Due:** $101,500.74
REPORT OF THE TREASURER—Continued

Expenditures:

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
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<tbody>
<tr>
<td>Interest</td>
<td>$ 12,042.37</td>
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<tr>
<td>Contingent Fund</td>
<td>570.33</td>
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<tr>
<td>Salary Expense General</td>
<td>19,712.52</td>
</tr>
<tr>
<td>Museum Department Salaries</td>
<td>20,547.50</td>
</tr>
<tr>
<td>Museum Department Appropriations</td>
<td>12,434.92</td>
</tr>
<tr>
<td>Bills Payable</td>
<td>10,000.00</td>
</tr>
<tr>
<td>Bills Receivable</td>
<td>7,000.00</td>
</tr>
<tr>
<td>Earthquake Insurance Sinking Fund</td>
<td>1,200.00</td>
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<tr>
<td>Insurance</td>
<td>727.87</td>
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<tr>
<td>American Trust Company Stock</td>
<td>1,650.00</td>
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<tr>
<td>Wild Life Protection Fund</td>
<td>67.64</td>
</tr>
<tr>
<td>Sundry Creditors</td>
<td>1,668.65</td>
</tr>
<tr>
<td>Expense</td>
<td>2,608.36</td>
</tr>
<tr>
<td>Library</td>
<td>7,669.85</td>
</tr>
<tr>
<td>Publication</td>
<td>7,734.69</td>
</tr>
</tbody>
</table>

$105,634.70

January 1, 1928, Balance due Crocker First National Bank... $ 4,133.96

M. Hall McAllister, Treasurer.

Examined and found correct,

McLaren, Goode & Co., Certified Public Accountants.

San Francisco, Calif., February 4, 1928.
## INCOME AND OPERATING EXPENSES

For the fiscal year, January 1, 1927, to December 31, 1927.

### Income:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
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</thead>
<tbody>
<tr>
<td>Charles Crocker Scientific Fund Endowment Income</td>
<td>$1,703.88</td>
</tr>
<tr>
<td>James Lick Endowment Income</td>
<td>$68,572.77</td>
</tr>
<tr>
<td>General Income</td>
<td>$18,724.11</td>
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<tr>
<td>Dues</td>
<td>$3,602.60</td>
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<tr>
<td>Interest from Temporary Investments</td>
<td>$1,012.90</td>
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<tr>
<td>Profit on Post Card Sales</td>
<td>$740.64</td>
</tr>
<tr>
<td><strong>Total Income</strong></td>
<td><strong>$94,356.90</strong></td>
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### Expenditures:

<table>
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<tr>
<th>Description</th>
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<tbody>
<tr>
<td>General Expense</td>
<td>$3,627.67</td>
</tr>
<tr>
<td>Salaries</td>
<td>$40,277.23</td>
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<tr>
<td>Interest</td>
<td>$12,042.37</td>
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<tr>
<td>Insurance</td>
<td>$925.27</td>
</tr>
<tr>
<td><strong>Total Expenditures</strong></td>
<td><strong>$56,872.54</strong></td>
</tr>
</tbody>
</table>

Net Income Transferred to Surplus Account: $37,484.36
SUMMARY OF SURPLUS ACCOUNT

December 31, 1927

Balance January 1, 1927.............................................. $498,729.49

Additions:
   Net Income for the year ended December 31, 1927......................... $37,484.36
   Sale of duplicate books........................................... 47.07

   Total Additions to Surplus......................................... 37,531.43

   $536,260.92

Deductions:
   Depreciation....................................................... 15,635.00

   Surplus, December 31, 1927........................................ $520,625.92
BALANCE SHEET

December 31, 1927

Assets

Property:
Real Estate 831-833 Market Street..............$600,000.00
Commercial Building, 833 Market Street.... 516,818.66
Real Estate, Jessie Street.................... 8,083.65

$1,124,902.31

Museum, Golden Gate Park:
Building Construction..........................$192,025.92
General Collections................................180,557.48
Library and Equipment............................126,670.55
Tools and Equipment.............................. 41,455.44
Office Furniture.................................. 4,952.54

545,661.93

Investment Securities.............................................. 18,250.00

Ignatz Steinhart Trust:
Bills Receivable........................................ $11,000.00
Steinhart Aquarium Construction.............. 263,390.29
Steinhart Aquarium Equipment............... 27,129.87
Steinhart Aquarium Revolving Fund.......... 5,000.00
Uninvested cash on hand.......................... 613.37

307,133.53

Current Assets:
Bills Receivable........................................ 14,000.00
Post Cards in Stock.............................. 1,024.12
Cash on hand........................................... 117.61
Sundry Accounts...................................... 100.00

15,241.73

Total............................................. $2,011,189.50
BALANCE SHEET—Continued

Liabilities

### Endowments:
- James Lick Endowment: $804,902.31
- Charles Crocker Scientific Fund Endowment: 20,000.00
- John W. Hendrie Endowment: 13,600.00

### Funds Held for Special Purposes:
- John W. Hendrie Endowment Income: $960.00
- Alvord Bequest Botanical: 5,000.00
- W. G. Wright Fund: 21.54
- Henry M. Holbrook Bequest: 25.28
- Park Birds Handbook Fund: 20.00
- Wild Life Protection Fund: 328.16

**Total Liabilities:** $838,502.31

### Reserve for Depreciation
**Principal:** $250,000.00
**Interest:** 57,133.53

**Total Reserve for Depreciation:** 307,133.53

### Ignatz Steinhart Trust:
- Principal: $250,000.00
- Interest: 57,133.53

**Total Ignatz Steinhart Trust:** 307,133.53

### Notes and Accounts Payable:
- Bills Payable: $215,000.00
- Accounts Payable, Sundry Trade Creditors: 1,138.87
- Due Crocker First National Bank (Overdraft): 4,133.96
- Due Ignatz Steinhart Trust: 613.37

**Total Notes and Accounts Payable:** 220,886.20

### Surplus
**Surplus:** 520,625.92

**Total:** $2,011,189.50

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Susie M. Peers,
Secretary, Board of Trustees.
We have examined the foregoing Balance Sheet, together with the books and accounts of the California Academy of Sciences, and in our opinion, it is properly drawn up so as to exhibit a true and correct view of the Academy's affairs, as shown by the books.

McLaren, Goode & Co.,

Certified Public Accountants.

San Francisco, Calif.,
February 4, 1928.
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President of the Academy

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Director of the Museum
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