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**No. 1**

# CRETACEOUS GEOLOGY OF LOWER CALIFORNIA*

BY

FRANK M. ANDERSON
*Honorary Curator Department of Paleontology*
*California Academy of Sciences*

AND

G. DALLAS HANNA
*Curator, Department of Paleontology*
*California Academy of Sciences*

## INTRODUCTION

During the last few decades a number of geologists have visited different parts of Lower California and have brought back much general information concerning the region. Most of the reports made by these visitors have dealt largely with the physical aspects of the country, or they have contained only general accounts of their geological observations, with a minimum of paleontological data.

In 1867 Wm. M. Gabb traversed the peninsula from Cape San Lucas to San Diego, a distance of 775 miles, making on his way north various excursions to the eastern and western coasts. His excellent account is, however, only general, and is based more upon his impressions of the country than upon scientific or convincing data.[1]

Since then W. Lindgren,[2] S. F. Emmons and G. P. Merrill,[3] and various others have visited portions of the peninsula, and have published their accounts. In 1921 N. H. Darton[4] accomplished a traverse

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[1] Wm. M. Gabb, Rept. Min. Res. U. S., 1868, pp. 630-639. A more detailed account is given in J. Ross Browne, Resources of the Pacific Slope, Appendix, pp. 82-102, D. Appleton & Co., N. Y., 1869.

[2] W. Lindgren, Proc. Calif. Acad. Sci., ser. 2, vol. 1, 1888, pp. 173-196.

[3] S. F. Emmons and G. P. Merrill, Bull. Geol. Soc. Amer., vol. 5, 1894, pp. 489-514.

[4] N. H. Darton, Jour. Geol., vol. 29, 1921, pp. 720-748.

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of a great part of its length, and his account contains numerous sectional sketches across the peninsula showing its geologic constitution and structures in a concise manner.

More recently considerable information concerning the Cretaceous rocks of this region has been obtained from the unpublished observations of G. D. Hanna, from published reports of the Marland Oil Company,[5] from the collections and reports made by Manuel Santillán and Tomás Barrera of the Mexican Geological Institute, and also from the collections and accounts of Charles H. Sternberg of San Diego; most of this information is embodied in the present paper, although abbreviated.

It has been claimed that much of the surface of the peninsula is underlaid by Cretaceous rocks, and although this view has been generally accepted, the basis for it appears to be little more than inference drawn from lithological appearances, or from other data not paleontological. The results are accordingly not always satisfactory, and have been misleading, as will be seen later.

Gabb described a yellowish, horizontally bedded sandstone as covering a large part of the southern half of the peninsula, which he called the "Mesa sandstone," and which he provisionally classed as Miocene, apparently from the lithological appearance. Concerning these sandstones he said, in part (p. 633, etc.):

> "After leaving the granite ranges south of La Paz the whole appearance of the country changes, and with it the geological structure. The granite itself has disappeared, only to show itself as one or two insignificant outliers, and in its place come enormous deposits of sandstone forming flat-topped mountains, ragged and precipitous along the east coast, sloping off so gradually toward the Pacific as to merge insensibly into the broad low plains of the west. . . .
>
> "The mesa sandstones are easily distinguished from the overlying rocks by their coarser grain, greater compactness, and above all by their being highly metamorphosed along the greater part of their eastern margins. Another marked feature is the presence of large quantities of boulders and pebbles of volcanic rocks embedded in them, sometimes to such an extent as to form even a preponderance of the bulk of the strata. . . . "

The surmise that the "Mesa sandstone" is of upper Cretaceous age began with the account by Lindgren of the beds at Todos Santos Bay near Ensenada. Lithologic resemblances and general geologic facts in his possession induced him to suggest their identity with the "Mesa sandstone" of Gabb. Other geologists have since adopted this view, but according to the sections drawn by Darton, the "Mesa sandstone" is underlaid by "yellow beds," and sections nos. 19 and 20, northwest of La Paz, show both to be underlaid by Eocene strata.

As the character, classification and distribution of the Cretaceous rocks found on the peninsula, proved and reported, constitute the chief concern of the present paper, a brief account of them and their geological background may be summarized in the following pages, as they have been described by others.

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Carl Beal, Bol. del Petroleo, vol. 17, no. 16, and vol. 18, no. 1, 1924.

*Maps.* The usual atlas maps of Lower California are nearly worthless for even general reconnaissance work. Therefore, we have given below a list of those which we have used and have found to be generally dependable.

1. For the outlines of coasts and islands and general navigation purposes the charts issued by the Hydrographic Office of the U. S. Navy are indispensable.[6] The general chart covering the whole of Lower California and the Gulf of California is No. 1006.

2. An excellent map of Lower California, (scale 1:1 M), showing most of the important roads, trails, towns, villages and the topography, (contour interval 100 meters), was published by the American Geographical Society, New York. The lower part of the peninsula north to Scammon Lagoon was published in 1923 as a "provisional edition." The northern part, still "provisional edition" appeared in 1928. These maps are marred by a few typographical and other errors, which, presumably will be corrected in the final edition; the northern section, for instance, is labelled "South America."

3. Carl Beal and associates in the Marland Oil Company made extensive geological explorations in Lower California about 1920-1923, in connection with a concession which had been granted to the company. The only report which has appeared regarding the general results of the field work is in three parts, unsigned, and in Spanish.[7] This report contains much information useful to the traveler in that desert country as well as details concerning the geology of localities not previously seen by trained observers.

4. Ings. Manuel Santillán and Tomás Barrera conducted explorations in northern Lower California in 1928 and published their results with a geological map in 1930.[8]

This is followed by reports by Hisakichi Hisazumi[9] and Dr. A.

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[6] A full list of the charts published by the Hydrographic Office of Western Mexico and Central America may be found in the publication: H. O. No. 84, Mexico and Central America Pilot (West Coast) sixth edition, Washington Government Printing Office, 1920, and the supplement to the same published in 1923. This publication also gives very valuable information on coastal depths, character of bottom sediments, place names and distances. See also Hanna, G. D. Proc. Calif. Acad. Science, ser. 4, vol. 15, 1926, p. 18, for a list of the most important sailing charts.

[7] [Part 1.] "Informe sobre la exploración Geológica de los Distritos de Altar, Hermosillo, Guaymas y Alamos, del Estado de Sonora, Mexico, por la Compañia Petrolera de Sonora, S. A."
Boletin del Petroleo, vol. 17, no. 5, May, 1924, pp. 362-379, 1 general map showing districts and boundary of concession, (pl. 1) and 24 plates of views, (pls. 2-25).

[Part 2.] "Informe sobre la exploración Geológica de la Baja California, por la Marland Oil Company of Mexico." Bol. d. Petrol. vol. 17, no. 6, June, 1924, pp. 417-453, 1 general map showing districts and boundaries of concession (pl. 1), and 40 plates of views, fauna, flora, etc., (pls. 4-10), 1 without number, 11, 12, 14-22, 26-46.

[Part 3.] "Informe sobre la exploración Geológica de la Baja California, por la 'Marland Oil Company of Mexico,' S. A." Bol. d. Petrol. vol. 18, no. 1, July, 1924, pp. 14-53, 1 geological map of entire peninsula and 16 plates of views, etc., (pls. 77-92).

[8] Manuel Santillán & Tomás Barrera, "Las possibilidades petroliferas en la costa occidental de la Baja California, entre los paralelos 30° y 32° de latitud norte." Anal. del Instituto d. Geologica d. Mexico, vol. 5, 1930, pp. 1-37, 1 geol. map (scale 1:2 M), and 12 photographic views.

[9] H. Hisazumi, "El Distrito sur de la Baja California." Anal. Inst. Geol. Mex. vol. 5, 1930, pp. 41-82 1 geol. map (scale 1:2 M), 7 cross sections of peninsula, 2 detailed sections, 2 block diagrams.

Pastor Giraud[10] on districts to the southward and in Sinaloa, which however, do not appear to mention any surface exposures of Cretaceous rocks.

5. An excellent map (scale 22.5 miles: 1 inch) for overland travel in Lower California was published in 1930 by the Automobile Club of Southern California. This shows the main route of travel from San Diego to Cape San Lucas and the topography is sketched in. The accompanying text gives much information of general interest.

6. Atlas Geografico de la Republica Mexicana, Secretaria de Agricultura y Fomento, Dirección de Estadios Geograficos y Climatologicos, Mexico D. F., 1919-1921; also in various editions up to 1929-1930. The first of the series (unnumbered) is a geological map of Mexico (scale 1:6.5 M) showing upper Cretaceous rather widely distributed in the Rosario coastal district and entirely across the peninsula from San Ignacio Lagoon to Santa Rosalia and northward along the Gulf coast. No. 3 is an excellent geographic map of Lower California, (scale 1:2 M), showing trails, habitations, water courses, etc.

7. Probably the best general account of Lower California with notes on previous scientific explorations and an extensive bibliography (444 titles) is that of Edward W. Nelson.[11] This, as well as many of the titles referred to in the bibliography, contains a great deal of information of interest to geologists and an excellent map.

## Pre-Cretaceous Rocks

The existence of pre-Cretaceous rocks, crystalline and metamorphic, upon the peninsula is evident from the account given by Gabb, and also in the accounts of all subsequent writers.

Lindgren's description of the formations about Todos Santos Bay shows the later Cretaceous strata as resting upon older porphyritic rocks, which may well be pre-Cretaceous as well as pre-Chico in age.

Emmons and Merrill gave a general section across the peninsula near parallel 30° north. In this section the unaltered rocks, Cretaceous and later in age, occupy a zone less than one-fourth the width of the peninsula, while older rocks make up the larger part of the section. The granitic and schistose rocks reported by Gabb are presumably pre-Cretaceous, as is generally the case in California, and this may be true also of the volcanic and other classes from which the boulders of the "Mesa sandstone" reported by Gabb have been derived.

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[10] A. Pastor Giraud, "Informe geologico del ex-Distrito de San Ignacio, Estado de Sinaloa." Anal. Inst. Geol. Mex. vol. 5, 1930, pp. 85-113, 5 maps and sections. [This Ignacio should not be confused with San Ignacio, Lower California.]

[11] Edward W. Nelson, Lower California and its natural resources, Nat. Acad. Sci. Washington, Mem. vol. 16, pt. 1, 1922, pp. 1-194, 34 pls. of views, etc., 1 map (scale about 24 miles: 1 inch), showing roads, trails, waterholes, etc. and the general topography.

Granites appear at the southern end of the peninsula and extend northward from there beyond La Paz. Other areas are found intermittently along its eastern border as far north as the boundary. The sections given by Darton show granite and other crystalline rocks which are presumably pre-Cretaceous, along the eastern border near latitude 28° to 30° and farther.

On the western border of the peninsula granitic and other crystalline rocks were reported by Gabb in the Sierra Santa Clara, extending from San Sebastian Bay southeastward along the coast, which here also should be pre-Cretaceous in age, following the rule in California.

In two of Darton's sections near Magdalena Bay similar rocks are shown, and in many of the off-shore islands to the west later reports reveal rocks that by the same rule should be pre-Cretaceous. Such rocks are shown in published reports and photographs[12] as occurring on Cedros Island (pl. 11, fig. 1), and on neighboring islands, and at certain points on the mainland.

## Cretaceous Deposits

*San Fernando Formation.* Lower Cretaceous rocks undoubtedly occur in Lower California, as they do in many other parts of the Pacific coast northward to Alaska, although they are here less well known paleontologically. On the map of the Marland Oil Company[13] there appear some large areas of rocks shown in the accompanying section as "metamorphic rocks," including limestones, slates, quartzites and intrusives, to which in the text (p. 49) are added conglomerates and sandstones. These appear to be the same rocks that were earlier described by Darton as "metamorphic Cretaceous," and which were later included by Santillán and Barrera[14] in their "Alisitos formation." As the account given by the geologists of the Marland Oil Company antedates that of the Mexican geologists, the name San Fernando formation seems to be appropriate, although the latter have given the only paleontological evidence as to the age of the group. In their discussion of the "Alisitos formation" they have given a considerable list of fossils, which, as determined by B. L. Clark, includes a number of forms generically named, which seem to indicate lower Cretaceous, and at least two species, *Amberlya dilleri* Stanton, and *Hypsipleura ? occidentalis* Stanton, well known in the Paskenta Group of the Shasta series in California. According to Darton the limestones are well filled with fossil oysters, which he regarded as of "upper Cretaceous age," although fossil oysters are not particularly diagnostic. The Paskenta group in California contains much limestone and also fossil oysters, both large and small.

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[12] G. D. Hanna, Pan-American Geologist, vol. 48, 1927, pp. 1-24.
[13] Carl Beal, Bol. del Petroleo, vol. 18, No. 1, 1924, opp. p. 52.
[14] Manuel Santillán and Tomás Barrera, An. del Inst. de Geol. vol. 5, 1930, pp. 9-14.

As far as can be learned from Darton's account his "metamorphic Cretaceous" differs in no respect from the San Fernando formation of Beal, or from the "Alisitos formation" of Santillán and Barrera.

Darton recognized only two principal series (groups), both of which he regarded as being of upper Cretaceous age, separated by an unconformity. The younger group he correlated with the "Chico" of California, whereas "the older series of unknown correlation" he described as "having been uplifted, flexed, and cut by large igneous masses before the youngest series, 'Chico', was deposited." The older series, which he did not find in immediate contact with the younger, he called the "pre-Chico," concerning which he says, in part (p. 726):

"These pre-Chico rocks consist of conglomerates, quartzites, tuffs, and agglomerates with large bodies of interbedded eruptive rocks. They are also cut by dikes and large stocks of igneous rocks of various kinds. In many localities the igneous rocks predominate over the sediments or pyroclastics, and in places there is much metamorphism. Unaltered, or but little altered sandstones and shales appear in places, notably near old San Domingo Mission, 25 miles north of San Quintin, where they contain large oyster shells, and in the Arroyo San José, 40 miles southeast of Santa Catarina. Limestone also occurs. It is conspicuous north and northeast of the ruins of Mission San Fernando, 30 miles due east of Rosario, . . . . "

From his statements and sectional diagrams there can hardly be a doubt that the "pre-Chico" group, which he also calls "metamorphic Cretaceous," is identical with the San Fernando formation of Beal, and the fact that it contains large oysters in no way conflicts with its determination as lower Cretaceous in age.

*Chico Group*. The first definite account of Cretaceous rocks on the peninsula was given by C. A. White[15] in 1885, in which he described the genus *Coralliochama* and a few other forms from the vicinity of Todos Santos Bay. This locality was later visited by Lindgren in January, 1888, and his account[16] adds to the information given by White.

Soon thereafter, H. W. Fairbanks made a further collection of fossils from this place, adding many species to the list then known,[17] and he reached the conclusion therefrom that these beds properly represented the Chico group of California, rather than an earlier unit, as was suggested by White. Since this visit by Fairbanks, large collections of fossils have been made at this locality for the California Academy of Sciences, and a long list of species is now known from there.

Although the list of species given by Fairbanks included some of Eocene age, 14 are clearly Cretaceous, and as here emended include the following:

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[15] C. A. White, U. S. Geol. Survey, Bull. No. 22, 1885, pp. 7-14.
[16] W. Lindgren, Proc. Calif. Acad. Sci., ser. 2, vol. 1, 1888, pp. 173-196.
[17] H. W. Fairbanks, Am. Jour. Sci., ser. 3, vol. 45, 1893, pp. 473-478.

Baculites chicoensis Trask
Coralliochama orcutti White
Glycymeris veatchi (Gabb)
Astarte mathewsoni Gabb
Aphrodina varians (Gabb)
Tellina ooides Gabb
Spisula ashburneri (Gabb)
Acila truncata Gabb
Leda translucida Gabb
"Ancyloceras" lineatus Gabb
Pugnellus sp.
Turritella chicoensis Gabb
Volutoderma sp.
Acteonina califia Stewart
Oligoptycha obliqua (Gabb)
Gyrodes expansa Gabb

Many species have since been obtained from this locality by the more recent collecting of C. H. Sternberg, L. G. Hertlein and E. K. Jordan. From these collections, as determined by the writers and Dr. Hertlein, the following may be added to the above list:

Baculites fairbanksi Anderson
Baculites occidentalis Meek
Tellina whitneyi Gabb
Tellina hoffmanni Gabb
Tellina mathewsoni Gabb
Tellina monilifera Gabb
Meekia navis Gabb
Modiolus cylindricus Gabb
Corbula traski Gabb
Lucina (?Myrtea) subcircularis Gabb
Anatina cf. affinis Whiteaves
Crassatellites tuscana (Gabb)
Venus steinyi Hertlein
Mactra gabbiana Anderson
Volutoderma gabbi White
Gyrodes californica Packard
Tornatella impressa Gabb
Tornatella normalis Cooper
Pugnellus rotundus Waring
"Ringicula" varia Gabb
Holzafilia sp.
Cirsostrema tenuisculptum Whiteaves
Trochus (Oxystele) euryostomus White
Acteon inornatus White
Lysis (Stomatia) intermedia (Cooper)
Ampullina sp.
Nerita sp.
Nuts of palms, etc.

According to Fairbanks, *Coralliochama* is found scattered through several hundred feet of strata. One bed four feet thick was composed almost entirely of these shells. In various localities in California this genus is found in beds that are regarded as low in the Chico group.[18] An inspection of the lists shows no other species that can be regarded as lower Chico, whereas, on the contrary, two-thirds of the number specifically named are found in middle Chico strata in the type districts of this group, and are probably not older than upper Turonian in age.

*The Rosario formation.* According to the account given by Beal,[19] a post-San Fernando emergence took place, which elevated the eastern part of the region, exposing this formation to erosion during the upper Cretaceous time, since in the sediments of the "Chico Cretaceous period (Rosario formation) there are found lenses of conglomerates which contain a large percentage of pebbles which seem to have come from this series" (p. 49).

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[18] The name "Chico" is used in this paper in a broad sense with full realization that at a later date it may be necessary to restrict it somewhat or even to confine it to the strata exposed in Chico Creek, California and its equivalents elsewhere.

[19] Carl Beal, Bol. del Petroleo, vol. 18, 1924, p. 49.

As described by Santillán and Barrera the Rosaria formation was regarded as the equivalent of the Chico group, and from it they have supplied a considerable number of species supporting this view, which, according to B. L. Clark, include many only generically named, and the following diagnostic forms:

| | |
|---|---|
| Baculites cf. fairbanksi Anderson | Turritella chicoensis Gabb |
| Schloenbachia sp. | Glycymeris veatchi (Gabb) |
| Trigonia leana Gabb | Inoceramus whitneyi Gabb |
| Trigonia evansana Gabb | Ostrea parasitica (Gabb) |
| Pholadomya cf. breweri Gabb | |

From Johnson's ranch, 15 miles south of Rosario, C. H. Sternberg obtained the following species, which for the most part seem to represent the same stratigraphic group:

| | |
|---|---|
| Nemodon breweriana (Gabb) | Gyrodes conradiana Gabb |
| Nemodon vancouverensis (Meek) | Tessarolax incrustata A. and H., n. sp. |
| Crassatellites tuscana (Gabb) | Turritella peninsularis A. and H., n. sp. |
| Inoceramus whitneyi Gabb | Dentalium (Entalis) whiteavesi A. and H. |
| Inoceramus cf. pembertoni Waring | Spondylus cf. rugosa Packard |
| Coralliochama orcutti White | Gryphaea sp. |
| Phacoides sp. | Ostrea sp. |

*Catarina Formation.* As viewed in the light of stratigraphic conditions found in the Coast Ranges of California within recent years it would appear that the conclusions reached by Emmons, Darton, and others regarding the upper Cretaceous sequence in Lower California will probably require revision. At least the upper part of the so-called "Chico formation," found about the mouth of Arroyo Santa Catarina, and in some localities farther north, is not different in age from an upper group of the Cretaceous found about Mount Diablo and in the Diablo Range in central California.

Attention has been called to this condition in a recent paper by J. A. Taff[20] in his discussion of the geology of Mount Diablo, California. He has found it necessary to revise the so-called "Panoche formation" of earlier writers, limiting it greatly, or in fact to a well defined upper part of the sequence to which the name had been applied. He says, in part (p. 1089):

> "It is now demonstrated by areal field mapping that a well defined upper part of the Panoche formation with a conglomerate at its base containing Chico boulders, described by Anderson and Pack, is stratigraphically and unconformably above the type Chico formation and is the middle formation of the tripartite upper Cretaceous series of the Mount Diablo area."

Similar stratigraphic conditions extend along the east flank of the Diablo Range for a distance of more than 200 miles, and are recog-

[20] J. A. Taff, Bull. Geol. Soc. Am., vol. 46, 1935, pp. 1088-1089.

nizable throughout the Coast Ranges of California, and farther to the north and to the south.

It seems probable that the so-called "Chico formation" on the peninsula of Lower California should be restricted in like manner, and that the upper part should be given a distinctive name, for which the locality of Arroyo Catarina supplies an appropriate term. G. P. Merrill explored the peninsula as far south as about latitude 30° north in 1892, and his geological observations appeared in a joint account by himself and S. F. Emmons,[21] to which reference has already been made.

*Type locality.* These authors supplied a brief account of the strata exposed about the lower part of the Arroyo Santa Catarina and also a list of upper Cretaceous fossils from the area which were determined by T. W. Stanton, who regarded them as of "Chico" age, in accordance with the usage of that time. This paper marked an important advance by supplying definite information as to the extension of upper Cretaceous deposits on the Pacific coast of the peninsula so far to the south. The beds exposed there are described, in part, in the following language:

"Midway in the reentering curve between Canoas and Bluff points is the Playa Santa Catarina, where there is a gap a mile or two in width between the bluffs bordering the ocean, formed by a broad valley in which there are two modern stream beds draining the interior region. They are divided at the shore line by a flat-topped ridge of Chico beds, near the top of which is the remnant of an ancient stream bed whose bottom is about 100 feet above tide water, and which is filled by a conglomerate of large boulders and water worn pebbles of massive rocks. . . . . The lower beds exposed in the bluffs along the coast have a gentle inclination northward and southward from Sandstone point, three miles north of Playa Santa Catarina, where massive sandstones form a slightly projecting headland. In these sandstones carbonized plant remains, too indefinite for identification, were found, and in the cracks of the immediately overlying clays were traces of petroleum. From these beds and from the calcareous layers about 200 feet above were obtained the following forms as determined by Mr. T. W. Stanton:

| | |
|---|---|
| Arca breweriana (Gabb) | Inoceramus sp. indet. |
| Baculites chicoensis Trask | Ammonites sp. indet. |
| Tessarolax distorta Gabb | Ostrea sp. indet." |

Eocene fossils were also found in overlying beds.

In California the latest Cretaceous group, described by Taff as unconformably overlying the Chico proper, is best developed and most prominent in the Diablo Range southeast of San Francisco Bay, although it is traceable from there southward through various areas to San Diego. It is distinctly of Senonian age, and in its upper part carries a rich upper Senonian fauna. At its base it contains heavy beds of conglomerate, as described by Anderson and Pack,

[21] S. F. Emmons and G. P. Merrill, Bull. Geol. Soc. Am. vol. 5, 1894, pp. 489-514.

marking a conspicuous unconformity existing between it and the Chico group, as determined by characteristic Chico fossils found in its embedded boulders. This group of strata makes up a large upper part of the so-called "Panoche formation," and in some parts of the Diablo Range attains a thickness of over 20,000 feet.

*Arroyo Santa Catarina.* The uppermost beds about the mouth of the Arroyo Santa Catarina have the same stratigraphic position, character, and invertebrate faunas as those found in the Diablo Range in California. Within the last few years several accounts have been given, and in part published, as the results of explorations by, or for the California Academy of Sciences into the peninsula of Lower California, and by others, including Manuel Santillán and Tomás Barrera, and the accounts and collections made by Charles H. Sternberg, of San Diego. In these there is much information as to the occurrence and stratigraphic conditions of the Cretaceous rocks on the west coast of the peninsula as far south as latitude 28° north. These rocks appear to extend along the ocean side much beyond this latitude, and they might be found to extend inland even to the Gulf coast, as Gabb has indicated.

Many of the fossils obtained by Santillán and Barrera near Arroyo Santa Catarina were left at the University of California. A part of the collections made there by Sternberg, including all of the species obtained, was acquired by the California Academy of Sciences (Loc. 1431, C. A. S.). As both collections were made at nearly the same place, and represent the same horizon, they have been combined in the list of species given below. The Sternberg collection formed the basis of a brief note with a photographic plate, published by one of the present authors in 1928.[22] Unfortunately, in this note two names were used that now need alteration. The *Pachydiscus caterinae* of this note is here described as *Parapachydiscus catarinae*, and *Baculites ovatoides* is now believed to be *Baculites inornatus* Meek.

The beds themselves from which these fossils were obtained are those described by Emmons and Merrill, only a short distance east from the coast line of the reentrant between Canoas and Bluff points. They here constitute the type area of the *Catarina formation* described in the preceding pages. The beds extend rather widely from this point, northward beyond Rosario, and southward along the coast, at least as far as the mouth of Arroyo Grande, according to the areal mapping of Santillán and Barrera, although included by them as a part of the Rosario formation.

The following list of species is representative of the faunas of these beds, many of which are regarded as new (Loc. 1431):

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[22] F. M. Anderson, Pan-Amer. Geol., vol. 50, no. 4, 1928, pp. 283-284, pl. 9.

Parapachydiscus catarinae A. and H.
Parapachydiscus peninsularis A. and H.
Parapachydiscus ootacodensis (Stoliczka)
Nostoceras sternbergi A. and H.
"Hamites" vancouverensis Gabb
Baculites occidentalis Meek
Baculites vagina Forbes
Nautilus campbelli Meek
Nautilus cf. d'orbignyanus Forbes
"Nucula" solitaria Gabb
Pecten sp.
Oligoptycha obliqua (Gabb)
Gyrodes conradiana Gabb
Perissolax sp.
Turritella peninsularis A. and H.
Turritella parallela A. and H.
Volutoderma cf. magna Packard
Clisocolus cordatus Whiteaves
Glycymeris veatchi (Gabb)
Aphrodina major (Packard)
Acila truncata Gabb

*Other localities.* Darton's contribution supplies some data (p. 727), including lists of Cretaceous fossils. From a locality 15 miles north of Rosario he obtained a number of forms, determined by Dr. Stanton, as follows:

Rhynchonella sp.
Inoceramus whitneyi Gabb
Baculites chicoensis Trask
Baculites occidentalis Meek
Gyrodes sp.
Ostrea sp.
Nemodon vancouverensis (Meek)
Cinulia obliqua Gabb
Anchura sp.
Dentalium sp.

Although Darton assigned the horizon of these species to the "Chico" group of the California sequence, it seems to be advisable to reserve judgment concerning it until further information is available.

Midway between Todos Santos Bay and San Quintin, in the vicinity of San Antonio del Mar, Santillán and Barrera collected the following species which were left at the University of California (Loc. 647 U. C. Coll.):

Nemodon breweriana (Gabb)
Nemodon vancouverensis Meek
Crassatellites sp.
Corbis peninsularis A. and H.

Santillán and Barrera obtained at Punta Abaja (Rosario landing), the following species which were also left at the University of California:

Glycymeris veatchi (Gabb)
Opis rosarioensis A. and H.
Mytilus sp.

Other localities in the vicinity of San Antonio del Mar, intermediate between Todos Santos Bay and San Quintin, were visited by L. G. Hertlein and E. K. Jordan, who obtained there considerable collections of upper Cretaceous fossils. These collections contain many additional species, some new, but none older than those of the preceding lists. The results of these explorations will doubtless appear in due time, and need not be given here.

Darton has shown no Cretaceous rocks on the peninsula in any of his sections south of No. 5, which is just north of Arroyo Santa

Catarina. Beyond this point many of his sections do not reach the coast and are therefore incomplete.

G. D. Hanna has visited coastal areas farther south, and the following paragraphs are taken from his unpublished notes. He examined a portion of Cedros Island, which in some points attains an altitude of nearly 4,000 feet. In his account of the central part of the southern half of the island, he says, in part:[23]

> "This portion of the island consists of thin-bedded and contorted cherts, slates and metamorphic rocks (pl. 11, fig. 1), partly surrounded on the north and east by Cretaceous shales and sandstones. Two extensive areas of Cretaceous exist on the island. One is near its south end in the canyon leading back from the Bernstein Abalone packing plant. About a mile inland there is a series of bald hills composed of thinly bedded, muddy shales. These weather readily into conspicuous rounded masses; on some of the slopes of these an occasional harder, iron-stained layer projects slightly above the general surface. The dip is constantly to the west at an angle of about 30° on the average, but in some cases it was noted to be as high as 45°. High mountains of schist and chert limit these deposits on the north and west, and eastwardly they are covered by Miocene and Pliocene. In one of the exposures on the north side of Bernstein Canyon a considerable number of poorly preserved fossils was found. These consist of *Ammonites*, and *Inoceramus*, some peculiar plant remains, and sundry nondescript Foraminifera. The assemblage is sufficient to determine the age as Cretaceous. . . . The other exposure of the same character of material is found some nine miles north of the one just described, and on the north side of the large central valley locally known as 'Grand Canyon,' but more correctly called Dearing Valley, after Veatch. The shales here reach an altitude of 2000 feet and probably more. The dip is again to the westward, the angle being in general about 30°. No fossils were found, but no part of the deposits have been searched carefully. Where the shales reach the coast there is a fringe of Pliocene about the base of the cliffs. . . . "

An examination of the fossils referred to above proves the Ammonite to be a species of *Phylloceras*, in size and sculpture very similar to *Phylloceras velledae* Michelin, although it might be an older form. The fragment of *Inoceramus* is not specifically determinable. However, in any case the Cretaceous beds outcropping here should be older than the Catarina formation, and they may well be lower Chico (Cenomanian or older), and such determination would harmonize with the structure of the region.

Although mountains of schist and chert are mentioned in the note, no metamorphism of the Cretaceous beds is indicated, and no eruptive dikes were seen cutting any of them, as was the case with the "metamorphic Cretaceous" described by Gabb, and later confirmed by Darton and by Beal. This fact might perhaps throw additional light upon the supposed age of the San Fernando formation, believed to be the equivalent of the "metamorphic Cretaceous."

North and south of Bernstein Canyon some volcanic rocks, granites, or gneisses, and other classes of pre-Cretaceous formations were noted, but the examination was not sufficiently thorough for any final conclusions.

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[23] G. D. Hanna, Manuscript notes.

The San Benito Islands, to the west of Cedros Island, are largely composed of cherts, supposed to be of Mesozoic age.

Natividad Island (pl. 11, fig. 2) lies between Cedros Island and the mainland to the south, concerning which we have the following note:

"This island lies about eight miles south of Cedros, and is almost entirely composed of hard muddy shales, sandstones and conglomerates. We landed at the south end and found nothing else to the north for a distance of about four miles, or almost the length of the island. The shore lines are mostly bold, due to the relative ease with which the rocks are carved by the sea. The attitude of the beds is so inconsistent in short distances that no certain view could be formed as to structures. The strata dip variously from 0° to 75°, and an equal discordance in strike leads to the supposition that the island is on, or very near a fault zone of major proportions. . . . "

This island forms a connecting link between the older rocks of Cedros Island and the granitic and metamorphic rocks of the Sierra Santa Clara, referred to by Gabb.

As to what formations cover the flanks of the Sierra Santa Clara we have little positive evidence. To the east are the "Mesa sandstones" described by Gabb; to the west the rocks resemble lithologically the Cretaceous strata on Cedros Island. Crystalline rocks seem to form the core of the range, and these are flanked along the southwest by two unconformable Cretaceous (?) groups. Referring to the formations found along the coast of the mainland, we have the following field notes (G. D. H.):

"Southeast of Turtle Bay about two miles, and partly beneath conspicuous hills of Pliocene and Miocene, there are some very prominent exposures of conglomerate. These dip to the southwest at about 30°, and strike northwest to southeast. The boulders are well rounded, the largest noted being about five inches in diameter. A great many of them are of quartzite. . . .

"It seemed at the time of our visit that on projecting the strike to the northwest the same beds should occur in the prominent range of hills beyond Turtle Bay, but this could not be investigated at the time. However, on the north side of the Bay, and east of the range of hills mentioned, there is a very extensive outcrop of hard sandstones and muddy shales. This exposure is on the bay shore and was carefully examined; the strata were estimated to have a thickness of at least 10,000 feet. The dip is constantly to the south, 80° west, and varies from 45° to nearly vertical, but no evidence of unconformity was seen. No fossils were found in these beds, but from their lithologic similarity to the rocks on Cedros Island, which contained fossils, they are believed to be Cretaceous."

The field notes, from which these quotations are extracted (G. D. H.), continue to the south, and include the following:

"The land surface in the immediate vicinity of Abreojos Point has been planed off and projects only a few feet above the sea. About 1000 feet of hard gray and brown sandstones and shales outcrop on the south side of the point. The strata strike northwest and southeast, and have a dip of 15° to the southwest. Immediately above, there are about 1500 feet of very hard, well cemented conglomerate with boulders up to eight inches in diameter. A slightly different dip and strike indicates the presence of an unconformity between the lower beds and this conglomerate.

. . . No fossils were found in these hard strata, but they were supposed to be Cretaceous, on account of their resemblance to the strata of that age on Cedros Island. . . . "

Carrying these observations even farther south along the Pacific coast of the peninsula, we have the following notes on the geology of Margarita Island, on the west side of Magdalena Bay:

"Santa Margarita is a high rugged island, 20 miles long and four wide, forming the outer barrier of the southern end of Magdalena Bay. It consists of two parts, connected in the center by a low isthmus. The high northern and southern parts are not well known geologically, but the meager evidence available indicates that they are composed of metamorphic and igneous rocks almost entirely. Near the center of the isthmus there is a conspicuous outcrop of thinly bedded sandstones (pl. 11, fig. 3) dipping westerly at about 80°. No fossils were found in them, but the amount of induration indicates that they are older than the Tertiary. . . . "

The photograph supports the belief that these beds are also Cretaceous, and they rest against the older metamorphic and igneous rocks beneath, that is, to the east, as is the case on the peninsula; more than this can not be said.

It would appear from the foregoing accounts that as a general condition of structure, as well as of composition, the peninsula of Lower California is not essentially different from the coastal parts of southern and central California. In its wider portions it appears to be outlined on both borders by axes of older crystalline or metamorphic rocks, between which rest gently dipping, or often much disturbed beds of later Cretaceous and Tertiary rocks, which in general occupy a synclinal trough. Some of the sections, as that to the south of Vizcaino Bay, show a distinct axis on the west border (Sierra Santa Clara) of which Cedros Island is a prolongation, recalling the structural conditions found in the Santa Maria and Salinas valleys of California.

## Stratigraphic Relations

The stratigraphic relations of the beds found in the several localities referred to in the foregoing text are not yet fully known, since only in part is there any indication found in the several accounts. The relations are, therefore, known only from the paleontological evidence that has been recorded, and this is not wholly satisfactory, largely from lack of sufficient material.

The list of invertebrate fossils obtained from Punta Banda, which at present is the most complete, contains no species that can be taken as representing strata older than middle Chico (lower Turonian), and most of the forms have been described from higher horizons. On the other hand, none of the species indicate a position as high in the column as that of the Catarina formation. *Coralliochama orcutti* White, of which this is the type locality, has sometimes been regarded as evidence of a lower Chico horizon, but this can hardly be accepted.

Its fossil associates at this locality do not support this view. According to Fairbanks[24] it occurs at Point Loma and at La Jolla, San Diego County, in beds that seem to be Senonian, rather than Turonian in age. This species is not identical with that found in lower Chico beds (Cenomanian, or older) occurring in the Cottonwood district, Shasta County, associated with abundant cephalopod forms.

The stratigraphic position of some of the beds about Rosario, as indicated by the fossils, is not higher than that at Punta Banda, and it may be lower. That higher beds are found in this vicinity seems to be probable as judged from the few species found near Rosario landing, and also at other points.

It has been shown that the strata constituting the Catarina formation are of upper Senonian age, and therefore higher than any of the beds at Punta Banda, or even at Rosario, from which the Rosario formation takes its name.

The Rosario formation, as indicated by the fossils collected by Santillán and Barrera, is not younger than Turonian. Its stratigraphic relations to the Catarina formation is inferred from its age, but has not been determined stratigraphically.

The stratigraphic relation of the Rosario formation to the underlying San Fernando formation appears to be one of unconformity, as stated and illustrated by Darton, and as seems to have been recognized by Beal and others. Darton named no fossil species as representing the older series (San Fernando), but reports limestones in it "filled with fossil oysters," which he took to be upper Cretaceous in age. Much limestone and various species of fossil oysters have also been found in the lowest group of the lower Cretaceous in California, and in Oregon, upon which Chico beds rest unconformably. Until the lower "series" described by Darton has been proved to be younger, it may be well to regard the same as probably belonging to the Shasta series. If the "older series" described by Darton should ultimately be proved to be of upper Cretaceous age, which seems unlikely, the unconformity might also be shown to be equivalent to that between the Chico group and the Panoche formation in California.

## CORRELATION

The Cretaceous deposits found in Lower California have been correctly regarded as geographical extensions of the contemporary deposits in California, and as such are capable of direct correlation with them. In so far as any faunal evidence has been recorded, or obtained, these deposits on the peninsula show the same stratigraphic succession as those found in the Diablo Range of central California. The oldest beds appear to belong low in the Cretaceous section, and have been correlated with the Paskenta group of the Shasta series.

[24] H. W. Fairbanks, Amer. Jour. Sci., vol. 45, 1893, pp. 473-478.

The upper Cretaceous deposits on the peninsula correspond in part to the Chico group in the Diablo Range, and in part to the later portion of the Panoche formation, as restricted by J. A. Taff, which lies unconformably upon Chico deposits in many parts of California, and farther to the north.

Equivalents of one or the other part of this upper Cretaceous sequence are spread along the Pacific coast through many degrees of latitude, namely along the coasts of Alaska, British Columbia, Washington, Oregon, northern and central California, Lower California, and to southern Chile, the Straits of Magellan and farther.

As known in California the upper Cretaceous deposits divide themselves into two distinct groups, lower and upper, and in part into smaller divisions. The older, or Chico group of the upper Cretaceous, is restricted in its stratigraphic span to that of its type districts, and geographically is confined to relatively smaller areas than the later group, due partly to overlaps. The later group is much thicker, and has a wider geographical range.

In California the Chico group has a chronological span from late Albian to late Turonian, whereas the beds so far found on the peninsula contain neither Albian nor Cenomanian strata. The lowest beds that have been regarded as upper Cretaceous, namely, those at Punta Banda, can hardly be older than middle Turonian. The horizons represented by the collections made between Punta Banda and Rosario, may be later, and may possibly be as late as lower Senonian, although no Ammonites have yet been found in them that would serve for determining this point.

The Catarina formation on the peninsula is not known to have the stratigraphic span of the Panoche formation in the Diablo Range, and may be equivalent to only its upper portion. Its known fauna is upper Senonian in age, but it may later be found to extend lower. The formation is not known to be unconformable upon the Chico group, or upon the beds that have been referred thereto, although this may later be shown to be the case.

The rich Senonian faunas in the Diablo Range can not be described here, although reference to them can hardly be avoided. They consist mainly of many genera and species of cephalopods as well as pelecypods and gastropods. Their horizon lies some 600 to 1000 feet below the contact of the Panoche formation, and the overlying Moreno formation, also Cretaceous. Similar beds are found in northern California and in Oregon. Other Pacific coast localities farther to the north are known in Vancouver Island and in the Straits of Georgia on some of its islands. Farther to the north they may occur about the Queen Charlotte Islands, or on the Alaskan coast, since they are found also in Japan.

In the opposite direction the upper Cretaceous beds known on the Quiriquina Island, southern Chile, have been classed by Steinmann[25] as of Senonian age. In fact, this author has correlated them

[25] G. Steinmann, N. Jahrb. f. Min. Geol., etc., Beil. Bd. 10, 1895, pp. 29-30.

with the Arrialoor (Valudayur) group in southern India, which are said to be unconformable upon older Cretaceous beds in that region. According to F. Kossmat,[26] these Arrialoor beds are of Senonian age, as shown by many cephalopod forms. According to Steinmann the equivalence of the Quiriquina beds to the Arrialoor is shown by the occurrence in both of many common species, and also by many analogues, all of which support this correlation.

In western Europe the nearest faunal equivalents of those found in the Catarina formation are in the upper Senonian (Campanian), and the same is probably true of the rich faunas of upper Panoche beds in the Diablo range. This correlation is supported by the presence in all of these Pacific coast beds of large forms of *Parapachydiscus*, by the gerontic forms, "*Hamites*" and *Nostoceras*, and by species of *Baculites*, including one very near to *Baculites vagina* Forbes, and also one near to *Baculites anceps* Lamarck.

Kilian and Reboul[27] have described a considerable fauna of upper Cretaceous age from Snow Hill and Seymour Island, on the borders of Antarctica, but without giving complete stratigraphic information. The lists of species contained in their account indicate strata ranging from Cenomanian to upper Senonian, or higher.

The more complete faunas described from this region are those of upper Turonian and Senonian (Campanian), or higher. These authors have compared the faunas of Snow Hill and Seymour Island with similar faunas on Vancouver Island, California, Chile, Patagonia, Natal, Pondoland, Madagascar, and other places. In their correlations (pp. 59-60) they say, in part:

> "It results from these comparisons that the Cretaceous formations of Snow Hill and Seymour Island correspond, on the whole, in their faunal characters to the Senonian (Santonian, Maestrichtian) of the Trichinopoly district in India, with which they may be synchronous."

The great majority of forms studied indicate a horizon of upper Cretaceous near to upper Senonian (Aturian-Maestrichtian) as is shown by the presence of such characteristic forms as *Phylloceras ramosum* Meek, *Pseudophyllites indra* Forbes, *Pachydiscus gollevillensis* d'Orbigny, *Anisoceras notabile* Whiteaves. In this correlation the species most relied upon are such as chiefly characterize the Catarina formation and their equivalents in the upper part of the Panoche formation in central California.

The complete evidence upon which these correlations rest cannot be given here, but some of the more common forms found in the Catarina formation are included in the descriptions of species in the latter part of this paper. On the following page is given a tentative correlation table of formations occurring on the peninsula with those of California and other regions.

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[26] F. Kossmat, Jahrb. d. K. K. Geol. Reichs. 1894, Bd. 14, p. 459.

[27] W. Kilian and P. Reboul, Wiss. Ergeb. der Schw. Sudpol. Exped. 1901-1903, Bd. 3, Lief. 6.

| | | | *Diablo Range* | *Santa Ana Mountains* | *San Diego* | *Lower California* | *Southern India* |
|---|---|---|---|---|---|---|---|
| Maestrichtian | | | | | | | |
| Senonian | Campanian | Panoche formation | Rich Cephalopod fauna | Cephalopod fauna | Pt. Loma-Cephalopod fauna | Catarina formation Cephalopod fauna | Arrialoor (Valudayur) |
| Senonian | Santonian | Panoche formation | Scanty fauna | - - - | | Johnson's ranch | |
| Senonian | Coniacian | Panoche formation | Conglomerate Unconformity | - - - - | | | |
| Turonian | | Chico group | Scanty fauna | | | Punta Banda beds | Trichinopoly beds |
| Turonian | | Chico group | | Lower fossil beds | | - - - | |
| Turonian / Cenomanian | | Chico group | Type Chico Fauna | | | | |
| Cenomanian | | Chico group | Lower Chico fauna | | | Cedros Island beds? | Ootatoor beds |
| Albian | | | Conglomerate Unconformity | | | | |

## Description of Species

In the following notes on the upper Cretaceous Mollusca of Lower California, various new species have been described briefly, with some references to their relationships elsewhere, as far as known. A few not new to science are also considered, with a view to ascertain the correct correlation of the strata discussed in the preceding pages. No attempt is made to give exhaustive references to the citations of other writers, which would prolong the present paper unduly, although enough is included to form a sort of key to the scattered literature of the particular species considered.

In some cases of synonomy corrections have been made, although with feelings of regret. It is possible that some of the names of doubtfully identified species will later need revision, and it is hoped that subsequent collections will considerably enlarge the lists herein contained, as well as extend the information as to the horizons of the Cretaceous here represented, and of their stratigraphic relations above and below.

Unless otherwise specified, the species contained in the following paragraphs, and especially the type examples, are to be found in the collections of the California Academy of Sciences and of the University of California.

### **Parapachydiscus catarinae** Anderson and Hanna, new species

Plate 1, figure 1; plate 2, figure 1; plate 3, figures 1–3

*Pachydiscus caterinae* Hanna and Anderson, Pan-Amer. Geol., vol. 50, no. 4, 1928, p. 238, pl. 9 (without description).

Shell very large, smooth, flattened on the sides, although moderately inflated; shell almost without surface ornamentation, or showing almost obsolete ribs, or undulations, which curve slightly forward; diameter of holotype, without body-chamber, 19.8 inches (50.3 cm.); height of whorl, from umbilicus to periphery at the last septum, 8.52 inches (21.6 cm.); height of preceding whorl, 3.42 inches (86.8 mm.); incremental ratio in last whorl, 2.49; ratio of umbilicus to last whorl, .200-.215, increasing gradually with growth of shell; ratio of involution to height of whorl, nearly .31; ratio of width of whorl to height, .79; periphery of septate portion of whorl, 53 inches (134.6 cm.).

*Holotype:* No. 4245 Mus. Calif. Acad. Sci. Paleo. was obtained from Loc. 1431 (C. A. S.), near **Santa Catarina Landing, Lower California**; paratypes, Nos. 4246 and 4247 are from the same locality.

This is the largest species of cephalopod yet seen in the Cretaceous of the Pacific coast. If the body-chamber occupied only one-quarter of a whorl the diameter would be 26 inches, or if it extended only 24 inches from the last septum, the diameter would be 28 inches.

The species is clearly a member of the group of *P. ootacodensis* (Stoliczka), which probably also includes *P. neevesi* Whiteaves, although the sutural characters of the latter are not known. Whiteaves believed them to be similar to those of *P. ootacodensis* (Stol.). Steinmann also compares *P. quiriquinae* Phil. with the Indian form, although its umbilical border is more rounded, and the section of the whorl is generally more inflated than in either *P. neevesi* or *P. catarinae.*

*Parapachydiscus catarinae* is also found in the uppermost beds of the Panoche formation in the Diablo Range, central California, and apparently in the same upper Senonian horizon.

### **Parapachydiscus ootacodensis** (Stoliczka)

Plate 6, figures 1, 2

*Ammonites ootacodensis* STOLICZKA, Cret. Ceph. S. India, vol. 1, p. 109, pl. 54, figs. 3, 4; pl. 56; (not pl. 57, vide Kossmat).

*Pachydiscus ootacodensis,* KOSSMAT, Beitr. z. Pal. Oest. Ung. u. des Orient. 1897, p. 98, pls. 16, 17, figs. 1a, 1b, etc. . . . WHITEAVES, Mes. Foss. vol. 1, pt. 5, p. 340, pl. 46, fig. 1; Hornby Island, British Columbia.

Whiteaves figured and described this species after having submitted his specimens to Kossmat for identification. He included Kossmat's notes in his discussion, which aid greatly in the recognition of our example from Lower California. The specimen from Catarina landing is 3 inches (76.2 mm.) in greatest diameter, the greatest thickness being 1.3 inches (33 mm.); it is septate throughout. The greatest umbilical diameter is about 0.75 inch (1.9 cm.), and the umbilical ratio, 0.254. The umbilical walls are abrupt within, not vertical, and rounded on the borders. The ribs are simple, low, rounded, spaced about one centimeter apart on the periphery, of which there are 24 on the complete whorl, curving slightly forward in the outer zone, and crossing the abdomen, which is somewhat narrowed.

*Plesiotype:* No. 4251 Mus. Calif. Acad. Sci. Paleo. from Loc. 1431 (C. A. S.) near **Santa Catarina Landing, Lower California.**

A careful comparison of our specimen with the figures given by Stoliczka and Whiteaves, aided by Kossmat's notes, makes the determination of the species appear quite satisfactory.

### **Parapachydiscus peninsularis** Anderson and Hanna, new species

Plate 4, figure 1; plate 5, figures 1, 2; plate 6, figures 3, 4;
plate 7, figure 5; text-figure 1.

Shell large, inflated, costate, moderately involute; section of whorl nearly semicircular in young stages (ratio 1:1.5); at a diameter of 3.25 inches (9 cm.) the ratio of height to width is 1.272; with increasing growth the ratio becomes smaller; at 14 inches (35.5 cm.) the ratio is reduced to 1:0.928; ribs about 56 in number, in two ranks; in shells 6 inches (15 cm.) in diameter, the ribs alternate; the stronger ribs slightly bullate on the umbilical border; ribs scarcely extending across the ventral zone; secondary ribs not bullate, more numerous than the primary, becoming reduced near the umbilical and ventral borders; walls of umbilicus abrupt in young shells, more rounded in larger individuals; ratio of umbilicus to diameter, varying from .226 in young stages to .222 in shells 14 inches in diameter.

Fig. 1. Septum of *Parapachydiscus peninsularis* Anderson & Hanna, new species. Drawn from Paratype, No. 4257 (C. A. S. Paleo. type coll.).

*Holotype:* No. 4248 Mus. Calif. Acad. Sci. Paleo. from Loc. 1431 (C. A. S.) near **Santa Catarina Landing, Lower California;** paratypes, Nos. 4249, 4250, 4253, 4257, same collection and locality.

In surface features this species greatly resembles *P. deccanensis* Stoliczka (in part), from the Arrialoor group of India. It appears, however, to belong to the group of *P. colligatus* Binckhorst, from the Senonian beds of Limbourg. The sutures (fig. 1) are not unlike those of *P. arrialoorensis* Stoliczka of southern India.

The species has been found in the upper Cretaceous beds of the Santa Ana Mountains, Orange County, together with a near relative, and in beds of the same age, upper part of the Panoche formation, in the Diablo Range near Coalinga, California.

A nearly related species is in the collections of Stanford University from the Santa Ana Mountains, and also a large fragment of *P. peninsularis* from near Coalinga, Fresno County. The species is associated with *P. catarinae*, and with "*Desmoceras*" cf. *damesi* Jimbo near Coalinga, in the upper beds of the Panoche formation.

## **Nostoceras** Hyatt

Genotype: *Nostoceras stantoni* Hyatt, Proc. Am. Phil. Soc., vol. 32, 1893, pp. 569-571; upper Cretaceous, Texas.

## **Nostoceras sternbergi** Anderson and Hanna, new species

Plate 7, figure 1; text figure 2

Shell rather large, the holotype consisting of the retroversal, body chamber of the shell, measuring 4.3 inches (10.9 cm.) in length, cylindrical in section, irregularly costate, irregularly nodose; last septum showing at the proximal end of the longer limb; costae of various sorts; some on the smaller limb are oblique, simple, narrow and sharp ridges which run continuously around whorl without dividing, separated by wider concave interspaces; others near the middle of this limb bifurcate on either side of the whorl and continue as the former; others beyond the middle of the limb branch into three divisions which cross the venter and join on the opposite side; others near the bend of the hook branch into five or six smaller costae, cross the venter and reunite again as the former; on the distal end of the body chamber the ribs are heavy, coarse and irregular, some dividing, others simple; nodes sharp, narrow and elongated, irregularly, distributed along the ventral borders, mostly reduced in size, or almost obsolete. An oblique constriction midway of the proximal limb extends continuously around the whorl.

Fig. 2. Septum of *Nostoceras sternbergi* Anderson & Hanna, new species. Drawn from Paratype, No. 4255 (C. A. S. Paleo. type coll.).

*Holotype:* No. 4254 Mus. Calif. Acad. Sci. Paleo. from Loc. 1431 (C. A. S.) near the mouth of **Arroyo Santa Catarina, Lower California;** paratype, No. 4255, same collection and locality.

Whiteaves figured and described a similar species under the name "*Anisoceras cooperi*" (Gabb), from Hornby Island, and it appears also to be irregularly costate, although more nodose than the species here described. He believed his species to be identical with Gabb's, and to the present writers this appears to be possible. An example of our species, retained by C. H. Sternberg, has somewhat more numerous nodes on the peripheral borders than are present on the holotype, although in other features the two are very similar. In all specimens of the species thus far seen the retroversal portion forms a loop approximately in one plane, turning downward at the septate end as if to connect with a sinstral helicoid spire, the surface features of which are at present not known. The species is named in honor of its discoverer, Charles H. Sternberg, the veteran collector of many vertebrate and other fossils throughout the western states.

At its type locality the species was associated with "*Hamites*" *vancouverensis* Gabb, *Parapachydiscus catarinae*, *P. peninsularis*, *P. ootacodensis* and many other species given in the preceding list.

A very similar, if not identical form was found at La Jolla, San Diego County, which is now in the Museum of Scripps Institution. It was loaned for study to the California Academy of Sciences by Dr. T. W. Vaughan, and was compared with the holotype.

### **"Hamites" vancouverensis** Gabb

Plate 7, figures 2, 3, 4; plate 8, figure 5

*Hamites vancouverensis* GABB, Geol. Surv. Calif. Pal., vol. 1, 1864, p. 70, pl. 13, fig. 18; Upper Cretaceous, Comox, Vancouver Island.

*Hamites (? Ancyloceras) vancouverensis* GABB, Geol. Surv. Calif. Pal., vol. 2, 1869, p. 212; Chico group, Vancouver Island.

*Hamites vancouverensis* GABB, WHITEAVES, Mes. Foss., vol. 1, pt. 2, 1879, p. 112; associated with *Pachydiscus newberryanus* Meek.

*Anisoceras cooperi* (Gabb), WHITEAVES, (in part), Mes. Foss., vol. 1, pt. 5, 1903, p. 336 (not pl. 43, fig. 1).

Although Whiteaves was inclined to unite *H. vancouverensis* and "*Anisoceras*" *cooperi* (Gabb) as being synonymous, his identification of the former was not positive. It seems likely that the form from Hornby Island (pl. 43, fig. 1) is really Gabb's species "*Amm.*" *cooperi*, although there are some differences apparent in the figures. In the specimens of *H. vancouverensis* Gabb from Catarina Landing, the ribs cross the venter (dorsum of Gabb and Meek), which is slightly flattened, and form on either side of the ventral zone, rows of depressed nodes which become more prominent on the distal limb of the body chamber, the ribs becoming here more widely spaced and at the same time stronger. The shell is sharply bent, forming a closely folded hook, the space between the limbs being less than half the width of the proximal limb. The septum is unknown.

In merging this species with *Emperoceras* (?) *cooperi* (Gabb), Whiteaves overlooked the fact that according to the description, *H. vancouverensis* has sharp and simple ribs crossing the venter, while in his own figure (pl. 43, fig. 1) the ribs divide on the side into two or more branches.

Three fragmentary specimens of *H. vancouverensis* were obtained by Srs. Barrera and Santillán near Santa Catarina Landing, and are in the collections of the University of California. A similar form, much compressed by rock pressure, has been loaned to the California Academy of Sciences by Dr. T. W. Vaughan for study; it was obtained at La Jolla, California.

Similar species are not uncommon in the upper Cretaceous deposits of California, although most of the examples are fragmentary.

### **Baculites occidentalis** Meek

Plate 8, figures 3, 4

*Baculites occidentalis* MEEK, Proc. Acad. Nat. Sci. Phila., vol. 13, 1861, p. 316.—MEEK, Bull. U. S. Geog. & Geol. Survey, Terr., vol. 2, no. 4, 1876, p. 366, pl. 4, figs. 1, 1*a*, 1*b*; Sucia Island, Straits of Georgia.—WHITEAVES, Mes. Foss., vol. 1, pt. 2, 1879, p. 115; pt. 5, 1903, p. 339; (*B. chicoensis* Whit. in part).

Meek's emended description of this species (1876, p. 366) reads:

"Shell attaining a medium size, very gradually tapering; section subtrigonal, excepting the smaller end, where it is more nearly ovate; antisiphonal, or broader surface flattened so as to give its lateral margins a more or less angular appearance; sides converging with slightly convex outlines from these angles to the narrowly rounded or obtusely angular siphonal margin; aperture subtrigonal, etc. . . . "

Meek gives a distinctive septum for this species (pl. 4, fig. 1b) which should leave no doubt as to its validity as a well marked upper Cretaceous, Pacific Coast form. It has not yet been positively identified in the lower or middle Chico beds of California, but occurs plentifully in the upper beds of the Diablo Group, and at Santa Catarina Landing, Lower California, in the same horizon.

### **Baculites inornatus** Meek

Plate 8, figures 1, 2

*Baculites inornatus* MEEK, Proc. Acad. Nat. Sci., Phila., vol. 13, 1861, p. 316; Sucia Island, Straits of Georgia.—GABB, Geol. Surv. Calif., Pal., vol. 2, 1869, p. 214; locality as above.

*Baculites chicoensis*, MEEK (in part, not Trask), Bull. U. S. Geog. & Geol. Survey, Terr., vol. 2, no. 4, 1876, p. 364, pl. 4, figs. 2, 2*a*, 2*b*, 2*c;* locality as above.

*Baculites ovatoides* HANNA and ANDERSON, Pan-Amer. Geol., vol. 50, no. 4, 1928, p. 283, pl. 9; nomen nudum.

It appears that Gabb did not recognize either of Meek's two West Coast species, *Baculites occidentalis* and *B. inornatus*, but figured a distinct form from Sucia Island, calling it "*B. occidentalis* Meek." It was perhaps this error that induced Meek to doubt the validity of either, supposing them both to be possibly varieties of *B. chicoensis* Trask, but this view appears to be untenable. In fact it is not difficult in most well preserved specimens to distinguish all three forms, although they often occur together. In the collections of the California Academy of Sciences there are numerous examples of *B. inornatus* from Sucia Island, showing well preserved suture lines. They differ considerably from *B. chicoensis*, of which Gabb has furnished a good illustration. As observed by Meek, *B. inornatus* is larger than *B. chicoensis*, has a distinctive suture and is more oval in section (not ovate) than *B. occidentalis*, and its sutural characters, as shown by his figures differ from all the others.

*Baculites inornatus* occurs in many places in California, and in Lower California, in upper beds of the Panoche formation, often associated with *B. occidentalis.*

*Plesiotype:* No. 4258 Mus. Calif. Acad. Sci. Paleo. is from Loc. 1431 (C. A. S.) Santa Catarina Landing, Lower California.

### **Nautilus campbelli** Meek

*Nautilus campbelli* MEEK, Proc. Acad. Nat. Sci. Phila., vol. 13, 1861, p. 318;—MEEK, Bull. U. S. Geog. & Geol. Survey, Terr., vol. 2, 1876, p. 373, pl. 6, figs. 2, 2*a*; Comox, Vancouver Island.—WHITEAVES, Mes. Foss., vol. 1, pt. 2, 1879, p. 99, pl. 11, (?) figs. 2, 2*a*, 2*b*; pt. 5, 1903, p. 327; locality as above.

This species has been obtained from the upper Cretaceous near the mouth of Arroyo Santa Catarina, Lower California. It appears to be very nearly related to *N. blanfordianus* Kilian & Reboul from the Island of Seymour and Snow Hill, Antarctica. According to these authors this latter species is identical with *N. bouchardianus* d'Orb., as identified by Blanford and Stoliczka, and probably also with *N. subplicatus* Philippi (in Steinmann) from Quiriquina Island on the Chilean Coast.

Two good specimens are in the collections of the California Academy of Sciences from Loc. 1431 (C. A. S.), near Santa Catarina Landing.

### **Nautilus d'orbignyanus** E. Forbes

*Nautilus d'orbignyanus* E. FORBES (in DARWIN), Geol. Obs. in S. America, 1851, p. 265, pl. 5, fig. 1.—STEINMANN, N. Jahrb. f. Min. Geol., etc., Beil. Bd. 10, 1895, p. 64; Island of Quiriquina, Coast of Chile.

This species is apparently abundant at various places in the upper Cretaceous deposits of Lower California, and has been obtained with the preceding near the mouth of Arroyo Santa Catarina, and at other points farther north on the peninsula. It has also been identified among the fossils collected from the Panoche formation of western Fresno County, California. Good examples are in the collections of the California Academy of Sciences from Loc. 1431 (C. A. S.) Santa Catarina Landing.

### **Turritella peninsularis** Anderson and Hanna, new species

Plate 10, figure 5

Shell of medium size, robust; whorls subangular; sutural grooves impressed, deep and broad; sides of whorls flattened or slightly concave; surface almost smooth on holotype, ornamented by faint revolving threads crossed by sinuous lines of growth; aperture sub-quadrate; spire high, tapering gradually to apex; whorls rounded on shoulders.

*Holotype:* No. 4709 Mus. Calif. Acad. Sci. Paleo. was obtained at Loc. 1430 (C. A. S.) at **Johnson's ranch, 15 miles south of Rosario, Lower California,** where it was found associated with other species given in a foregoing list.

In size and form, as also in ornamentation, this species greatly resembles *T. pachecoensis* Stanton, an Eocene (Martinez) form from central California, and indeed it is not readily distinguished from it. Our species occurring on the peninsula of Lower California associated with many well known Cretaceous species, requires a distinctive name, and for this reason the above is proposed for it.

### **Turritella parallela** Anderson and Hanna, new species

Plate 9, figs. 1, 2, 3

(?) *Turritella seriatim-granulata* GABB (not ROEMER), Geol. Surv. Calif. Pal., vol. 1, 1864, p. 132, pl. 20, figs. 88; Tuscan Springs, Tehama County, California; vol. 2, 1869, pp. 227, 263; loc. as above.—STEWART, Proc. Acad. Nat. Sci. Philadelphia, vol. 78, 1926, p. 348, pl. 21, fig. 2; (one of Gabb's specimens).

Gabb believed he had recognized Roemer's Texas species in the Chico beds of California, and doubtfully referred to others as possible synonyms. A comparison of his figures with those referred to and a study of his description do not support the identification, although there is a general resemblance in the ornamentation. The much narrower apical angle and the greater elongation of the form here considered, and of all California species thus far seen, remove them from any suspicion of identity with the Texas forms. In the holotype here used as the basis of comparison the shell is very slender, elongated, tapering very gradually or almost imperceptibly; sides of whorls flat, or only slightly convex; sutures slightly impressed; whorls banded with four or five beaded threads, the super-sutural one being heavier and smoother than the others; above this the three or four on the body of the whorl are beaded or granulated, the beads occurring in a series sloping downward to the right; beads seen only with a good lens; aperture not shown in the holotype. So gradually does this shell taper that in some fragments it is difficult to decide which is the basal, and which the apical end.

*Holotype:* (Univ. of California Coll. Paleontology) obtained near **Santa Catarina Landing,** from the upper Cretaceous beds there exposed.

### **Volutoderma** cf. **magna** Packard

*Volutoderma magna* PACKARD, Univ. Calif. Publ. Geol., vol. 13, 1922, p. 432, pl. 37, fig. 1; Santa Ana Mountains, Orange County, California.

Two imperfect specimens of a *Volutoderma* were obtained from the upper Cretaceous beds near Santa Catarina Landing, which appear to be more closely related to the above species than to any other known from the Pacific Coast, although both are somewhat narrower than the holotype at the University of California. One of the specimens from Lower California is in the Paleontological Collection of the California Academy of Sciences.

### **Tessarolax incrustata** Anderson and Hanna, new species

Plate 9, figures 4, 5

Shell of medium size, robust, biconic; height of holotype (incomplete at base), 43 mm.; width of body-whorl, 30 mm.; height of spire, 30 mm.; spire accuminate, heavily incrusted, whorls concealed; body-whorl inflated, bicarinate, angulated at base and above it, bearing on the lower angle two or three obtuse spines, heavily incrusted; aperture broad, sub-quadrate, ending above in a long and broad ascending canal against the spire; ascending canal ending abruptly above, curving outward at its top, forming a V-shaped notch; outer lip angulated, digitate; inner lip smooth, heavily incrusted, forming at the outer margin a projecting ledge, bearing on the body-whorl a narrow nodular process, or expansion; base of body-whorl abrupt, anterior canal not shown, but apparently not much produced; entire shell encrusted as if it had been completely covered by a mantle.

*Holotype:* No. 4262 Mus. Calif. Acad. Sci. Paleo. from **Johnson's ranch, midway between Rosario and Santa Catarina Landing, Lower California.** Paratype, No. 4263 is from the same locality, 1430 (C. A. S.).

*Tessarolax distorta* Gabb is a much more slender and smaller form, has a high and narrow spire, and much longer digitate canals than the present species. It was described from the Chico beds at Tuscan Springs, Tehama County, California. "*Helicaulax*" *bicarinata* Gabb is a related species, but it has many points of difference; it was described from lower Horsetown beds near Ono, Shasta County, California.

### **Dentalium (Entalis) whiteavesi** Anderson and Hanna, new species

Plate 6, figure 5

*Entalis cooperi* WHITEAVES, Mes. Foss., vol. 1, pt. 2, 1879, p. 134, pl. 16, figs. 10, 10*a*; pt. 5, 1903, p. 372; (not *Dentalium cooperi* Gabb, Geol. Surv. Calif. Paleont., vol. 1, 1864, p. 139, pl. 21, fig. 100, an Eocene species).

Shell large, curved, tapering, somewhat polished, ornamented only by irregular lines of growth, without longitudinal striae; cross section nearly circular.

*Holotype:* No. 4252 Mus. Calif. Acad. Sci. Paleo. from **Johnson's ranch,** Loc. 1430 (C. A. S.) **between Rosario and Santa Catarina Landing, Lower California.** Its length (incomplete) is 110 mm.; width at base, 14 mm.

This species has been found at Hornby Island, and has been referred by Whiteaves to Gabb's Eocene species, *D. cooperi*, described from near San Diego, California. This species is smaller than the present form, has longitudinal striae, and a different cross section.

*D. whiteavesi* is also found in the upper beds of the Panoche formation near Coalinga, Fresno County, and in similar beds on the western border of the lower Sacramento Valley, north of Winters. It is not known to occur in any Eocene strata on the west coast.

### **Nemodon vancouverensis** (Meek)

*Arca vancouverensis* MEEK, Trans. Alb. Inst., vol. 4, 1857, p. 40; Comox, Vancouver Island.

? *Grammatodon vancouverensis* MEEK, Bull. U. S. Geog. & Geol. Survey Terr., vol. 2, no. 4, 1876, p. 356, pl. 3, figs. 5, 5*a*;—White, Bull. U. S. Geol. Survey, no. 51, 1889, p. 34.

*Nemodon vancouverensis* WHITEAVES, Mes. Foss., vol. 1, pt. 5, 1903, p. 392—GABB, Geol. Surv. Calif. Pal., vol. 2, 1869, p. 249.

This species was originally described from the upper Cretaceous beds of Vancouver Island, but has since been found in strata of the same age in California (Coalinga), and two imperfect, although recognizable examples were obtained at the Johnson ranch, Loc. 1430 (C. A. S.); one of these is now in the paleontological collection of the California Academy of Sciences.

### **Aphrodina major** (Packard)

*Meretrix nitida* GABB, var. *major* PACKARD, Univ. Calif. Publ., Geol., vol. 13, 1922, p. 425, pl. 33, fig. 2; Santa Ana Mountains, Orange County, California; (not *M. nitida* GABB, Chico and Cow Creeks, northern California).

This species is abundant and well known in the upper Cretaceous deposits in the Santa Monica and Santa Ana Mountains, southern California; at Point Loma, San Diego County, and at numerous places on the peninsula of Lower California. It seems to be more nearly related to *Aphrodina varians* Gabb, than to *Aphrodina nitida* (Gabb).

The distinctions between the two forms were indicated by Gabb, (Geol. Surv. Calif. Pal., vol. 1, 1864, p. 165).

A single specimen of this species was obtained at Loc. 1431 (C. A. S.) near Santa Catarina Landing, Lower California.

### **Clisocolus cordatus** Whiteaves

*Clisocolus cordatus* WHITEAVES, Mes. Foss., vol. 1, pt. 2, 1879, p. 157, pl. 18, figs. 3, 3*a*, 3*b*; pt. 5, 1903, p. 384; Nanaimo River, Vancouver Island, and nearby points.

A single specimen of this species in good state of preservation was obtained at Loc. 1431 (C. A. S.) near Santa Catarina Landing. It differs in no important characters from the form described by Whiteaves from Vancouver Island, nor from the excellent examples of the same species obtained by the California Academy of Sciences from Sucia Island, Straits of Georgia.

This species is not well known from the upper Cretaceous beds of California, although a similar but smaller species has been found by the writers.

### **Crassatellites tuscana** (Gabb)

*Astarte tuscana* GABB, Geol. Surv. Calif. Pal., vol. 1, 1864, p. 179, pl. 30, fig. 257; Tuscan Springs, Tehama County, California; vol. 2, 1869, p. 244, loc. as above.

*Astarte conradiana* WHITEAVES (not GABB), Mes. Foss., vol. 1, pt. 2, 1879, p. 160, pl. 18, figs. 5, 5*a*, (not fig. 6); Sucia Island, Straits of Georgia.

Cf. *Veniella crassa* WHITEAVES, Mes. Foss., vol. 1, pt. 2, 1879, p. 153, pl. 18, fig. 1; Sucia Island.

A single example of this species was obtained from Johnson's Ranch, midway between Rosario and Santa Catarina Landing, Lower California.

Whiteaves seems to have recognized the form among the species he obtained from the upper Cretaceous deposits of Sucia Island, but unfortunately, the numbers on his figures seem to have been reversed (pl. 18, figs. 5, 5*a* and 6). As may be seen by referring to Gabb's figures (pl. 24, fig. 161, and pl. 30, fig. 257), *C. tuscana* is the shorter and heavier species.

The specimen from Lower California resembles very much in outline and surface markings the figure of "*Veniella crassa*" Whiteaves.

### **Spondylus** cf. **rugosus** Packard

*Spondylus rugosus* PACKARD, Univ. Calif. Publ. Geol., vol. 13, 1922, p. 422, pl. 26, fig. 3; pl. 29, fig. 3; pl. 30, fig. 3; "Chico group," Santa Ana Mountains, Orange County, California.

Two badly weathered specimens of a *Spondylus* were obtained from the upper Cretaceous beds near Santa Catarina Landing. They appear to be referable to the above species described by Packard, having the numerous radiating ribs and the fine crenulations on the interior of the lower margin, as noted in his description. They are, however, of the size, form and general aspect of the species described by the same author as *Spondylus striatus*, for which no inner crenulations were mentioned in the description.

### **Inoceramus pacificus** Anderson and Hanna, new species

Plate 10, figure 4

Cf. *Inoceramus cripsianus* (MANTELL), STOLICZKA, Cret. Fauna S. India, vol. 3, 1871, p. 405, pl. 27, figs. 1, 1*a*; Arrialoor group, southern India.

Shell large, sub-quadrate, elongate, beaks almost terminal, strongly incurved; hinge margin extended, straight, elevated behind; anterior end abrupt, slightly rounded below; basal margin broadly rounded in outline; surface bearing strong concentric undulations on the upper half, becoming obsolete below. Length of holotype, 142 mm.; height 88 mm.; thickness 70 mm. (estimated).

*Holotype:* No. 4266, Mus. Calif. Acad. Sci. Paleo. from Loc. 1430, (C. A. S.) **Johnson's ranch, midway between Rosario andSanta Catarina Landing.**

Zittel[28] has given many illustrations of *Inoceramus cripsii* Mantell showing extraordinary variations of the European form and a long list of names regarded by him as synonymous. Under the name *Inoceramus cripsianus* (Mant.), Stoliczka[29] has figured an Indian species as representing the same. Although the peninsular species clearly belongs to the group of *I. cripsii* Mant. it scarcely comes within the range of variations shown by Zittel. It resembles more nearly Stoliczka's Indian form, although it is less produced in front, and the undulations on the sides do not extend so low as in the latter. It is therefore regarded as a distinct species, although further discoveries may prove the contrary, or that it is identical with the Indian form. There is also some resemblance between our species and *I. pembertoni* Waring, but in the latter the beaks are high and terminal.

### **Inoceramus whitneyi** Gabb

*Inoceramus whitneyi* GABB, Geol. Surv. Calif. Pal., vol. 2, 1869, pp. 193, 247, pl. 32, fig. 91; Chico group, Folsom, California;—ANDERSON, Proc. Calif. Acad. Sci., ser. 3, vol. 2, 1902, pp. 31, 34, 37, etc.—WARING, Proc. Calif. Acad. Sci., ser. 4, vol. 7, 1917, p. 62, pl. 8, fig. 9; Calabasas, California.—STANTON (in DARTON) Jour. Geol., vol. 29, 1921, p. 727; Lower California.

This species is very well known in the upper Cretaceous of California, occurring abundantly in its upper division. It has been found at various places in Lower California, including the Johnson ranch, north of Santa Catarina Landing and at neighboring points. A very similar, if not identical form has been found in upper Cretaceous beds of Sucia Island, which is now in the paleontological collection of the California Academy of Sciences.

Attention may be called here to the resemblance in form, size and surface ornamentation of this species and *Inoceramus subundatus* (Meek)[30] and to the discussion of the latter species by Whiteaves.[31] This latter species was described from Sucia Island, Straits of Georgia. In the collections of the California Academy of Sciences there are several good specimens of Meek's species from this locality, and also many well-preserved specimens of *I. whitneyi* Gabb, from various localities in California. A comparison of these examples shows very clearly their close relationship, and at least their analogy, although the northern form appears to be somewhat more inflated.

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[28] Karl A. Zittel, Denkschr. d. K. Akad. Wiss., Wien., vol. 25, 1866, pt. 2, p. 95, pls. 14, 15.
[29] F. Stoliczka, Cret. Fauna S. Ind., vol. 3, 1871, p. 405, pl. 27, figs. 1, 1*a*.
[30] F. B. Meek, Bull. U. S. Geol. & Geog. Surv. Terr., vol. 2, no. 4, 1876, p. 358, pl. 3, figs. 1, 1*a*, 3, 3*a*.
[31] J. F. Whiteaves, Mes. Foss. vol. 1, pt. 2, 1879, p. 172; pt. 5, 1903, p. 397.

### **Corbis peninsularis** Anderson and Hanna, new species

Plate 10, figure 1

Shell moderately inflated, almost circular in outline, smooth, without radial markings on the surface; surface marked only by evenly spaced concentric lines of growth; umbones low, curving forward, not widely separated; lunule obsolete or absent; posterior margin rounded; dentition not shown. Length 60 mm.; height 60 mm.

*Holotype:* Univ. Calif. Coll. from Loc. 467, **midway between Ensenada and San Quintin, Lower California;** collected by Ings. Barrera and Santillán.

### **Opis rosarioënsis** Anderson and Hanna, new species

Plate 10, figures 2, 3

Shell subtriangular, broadly rounded at the base, straight on anterior border, rounded behind; umbones strongly incurved; lunule deep, ovate in outline, bordered within by an impressed marginal groove, bordered without by a slightly broader, almost smooth area surrounded by a thin raised lamella; holotype (broken on lower margin) measuring 2.3 inches (5.8 cm.) in length; 2.6 inches (6.6 cm.) in height; depth of single valve one inch (2.54 cm.); lunule 0.9 inch (2.3 cm.) in height; surface marked by flattened area behind, forming a strong umbonal ridge; strong concentric lines of growth, and anterior extra-lunular area; dentition not shown.

*Holotype:* Univ. Calif. Coll. from Loc. A-426, **near Rosario Landing, Lower California,** collected by Ings. Barrera and Santillán.

### **Coralliochama orcutti** White

*Coralliochama orcutti* White, U. S. Geol. Survey, Bull. 22, 1885, p. 10, pls. 1, 2, 3, 4; Todos Santos Bay, Lower California.—Fairbanks, Am. Jour. Sci., ser. 3, vol. 45, 1893, pp. 474, 475, 477, etc.—Anderson, Proc. Calif. Acad. Sci., ser. 3, vol. 2, 1902, pp. 38, 75.

This species was first described from Todos Santos Bay, Lower California, but has since been found at Point Loma, La Jolla, and at other points, and is reported from as far north as the Mendocino coast of California.

Good specimens were obtained by Chas. H. Sternberg at Johnson's ranch, midway between Rosario and Santa Catarina Landing, and are now in the paleontological collection of the California Academy of Sciences.

Although the species has been reported from the lower Chico beds of the Cottonwood district, Shasta County, a comparison of specimens recently found there with excellent examples from the type locality do not support the view as to their identity.

## PLATE 1

Fig. 1. *Parapachydiscus catarinae* Anderson & Hanna, new species. Holotype, No. 4245 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; diameter 503 mm.; p. 19.

## PLATE 2

Fig. 1. *Parapachydiscus catarinae* Anderson & Hanna, new species. Paratype, No. 4246 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; diameter 190 mm.; p. 19.

## PLATE 3

Fig. 1. *Parapachydiscus catarinae* Anderson & Hanna, new species. Paratype, No. 4246 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; thickness 77 mm.; p. 19.

Fig. 2. *Parapachydiscus catarinae* Anderson & Hanna, new species. Paratype, No. 4247 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; diameter 79 mm.; p. 19.

Fig. 3. *Parapachydiscus catarinae* Anderson & Hanna, new species. Paratype, No. 4247 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; thickness 36 mm.; p. 19.

## PLATE 4

Fig. 1. *Parapachydiscus peninsularis* Anderson & Hanna, new species. Holotype, No. 4248 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; diameter 355 mm.; p. 20.

## PLATE 5

Fig. 1. *Parapachydiscus peninsularis* Anderson & Hanna, new species. Paratype, No. 4249 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; thickness 66 mm.; p. 20.

Fig. 2. *Parapachydiscus peninsularis* Anderson & Hanna, new species. Paratype, No. 4249 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; diameter 117 mm.; p. 20.

## Plate 6

Fig. 1. *Parapachydiscus ootacodensis* (Stoliczka). Plesiotype, No. 4251 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; diameter 76 mm.; p. 20.

Fig. 2. *Parapachydiscus ootacodensis* (Stoliczka). Plesiotype, No. 4251 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; thickness 33 mm.; p. 20.

Fig. 3. *Parapachydiscus peninsularis* Anderson & Hanna, new species. Paratype, No. 4250 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; diameter 41.5 mm.; p. 20.

Fig. 4. *Parapachydiscus peninsularis* Anderson & Hanna, new species. Paratype, No. 4250 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; thickness 26 mm.; p. 20.

Fig. 5. *Dentalium* (*Entalis*) *whiteavesi* Anderson & Hanna, new species. Holotype, No. 4252 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; length 110 mm.; diameter at base, 14 mm.; p. 27.

## Plate 7

Fig. 1. *Nostoceras sternbergi* Anderson & Hanna, new species. Holotype, No. 4254 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; length 109 mm.; p. 22.

Fig. 2. "*Hamites*" *vancouverensis* Gabb. Plesiotype in University of California coll. from Santa Catarina Landing, Lower California; p. 23.

Fig. 3. "*Hamites*" *vancouverensis* Gabb. Same specimen as fig. 2; thickness 29 mm.; p. 23.

Fig. 4. "*Hamites*" *vancouverensis* Gabb. Cross section of same specimen as fig. 2; p. 23.

Fig. 5. *Parapachydiscus peninsularis* Anderson & Hanna, new species. Paratype, No. 4253 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; diameter 89 mm.; thickness 55 mm.; p. 20.

## Plate 8

Fig. 1. *Baculites inornatus* Meek. Plesiotype, No. 4258 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; diameter in center 44 mm.; length 140 mm.; p. 24.

Fig. 2. *Baculites inornatus* Meek. Cross section of specimen shown in fig. 1; *s* indicates position of siphon; p. 24.

Fig. 3. *Baculites occidentalis* Meek. Plesiotype in University of California coll. from Santa Catarina Landing, Lower California; p. 24.

Fig. 4. *Baculites occidentalis* Meek. Cross section of specimen shown in fig. 3; *s* indicates position of siphon; p. 24.

Fig. 5. "*Hamites*" *vancouverensis* Gabb. Plesiotype in University of California coll. from Santa Catarina Landing, Lower California; length of fragment 85 mm.; p. 23.

## PLATE 9

Figs. 1, 2, 3. *Turritella parallela* Anderson & Hanna, new species. Three photographs of a block containing numerous specimens; holotype, the sculptured shell of fig. 3, length 17.5 mm.; from Santa Catarina Landing, Lower California, now in the University of California coll.; p. 26.

Fig. 4. *Tessarolax incrustata* Anderson & Hanna, new species. Holotype, No. 4262 (C. A. S. Paleo. type coll.) from Johnson's Ranch between Rosario and Santa Catarina Landing, Lower California; height 43 mm.; p. 27.

Fig. 5. *Tessarolax incrustata* Anderson & Hanna, new species. Same specimen as fig. 4; p. 27.

## PLATE 10

Fig. 1. *Corbis peninsularis* Anderson & Hanna, new species. Holotype in University of California coll., from midway between Ensenada and San Quintin, Lower California; height 60 mm.; p. 31.

Fig. 2, 3. *Opis rosarioënsis* Anderson & Hanna, new species. Holotype in University of California coll., from near Rosario Landing, Lower California; length 58 mm.; thickness of single valve 25.4 mm.; p. 31.

Fig. 4. *Inoceramus pacificus* Anderson & Hanna, new species. Holotype, No. 4266 (C. A. S. Paleo. type coll.) from midway between Rosario and Santa Catarina Landing, Lower California; length 142 mm.; p. 29.

Fig. 5. *Turritella peninsularis* Anderson & Hanna, new species. Holotype, No. 4709 (C. A. S. Paleo. type coll.) from Santa Catarina Landing, Lower California; length 61 mm.; maximum width 21.6 mm.; p. 25.

## PLATE 11

Fig. 1. Exposures of chert strata (? pre-Cretaceous); Dearing Canyon, middle of east side of Cedros Island, Lower California; looking south, showing dip to southwest.

Fig. 2. Exposure of strata (? upper Cretaceous) on west side of Natividad Island, Lower California; looking southeast, showing dip to southwest.

Fig. 3. Sedimentary strata (? upper Cretaceous), Margarita Island, Lower California; looking northeast, showing steep dip to southwest.

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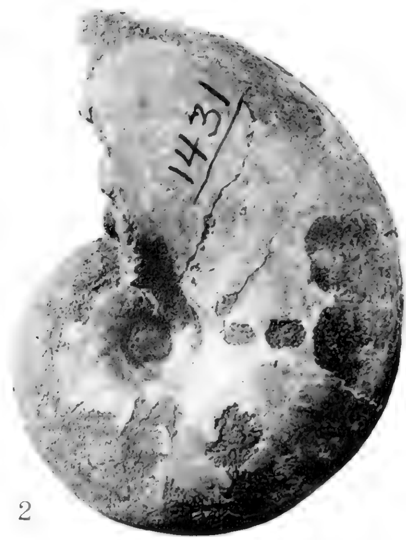


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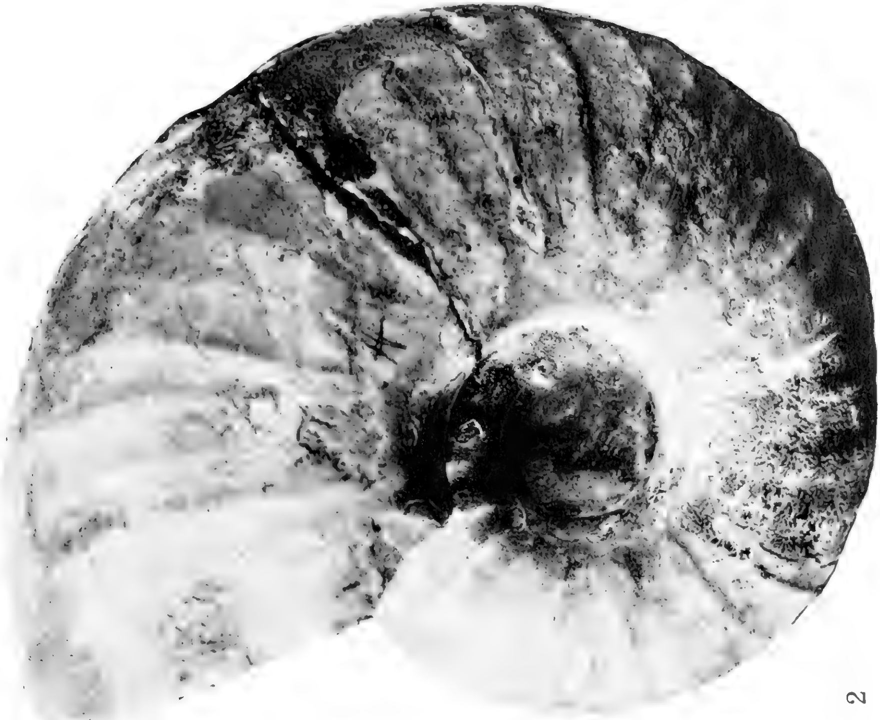

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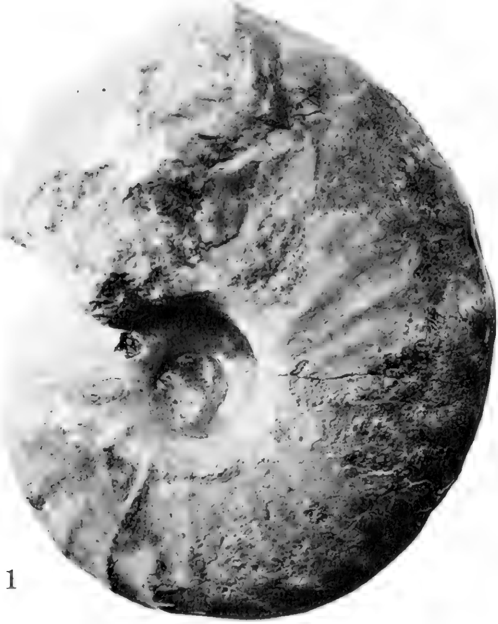

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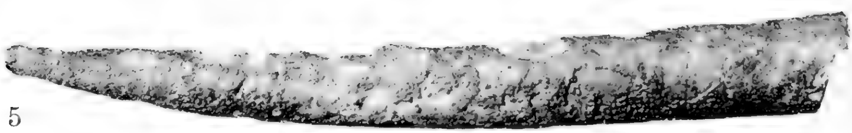

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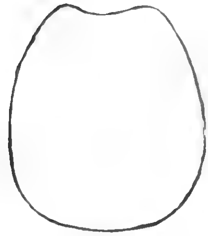

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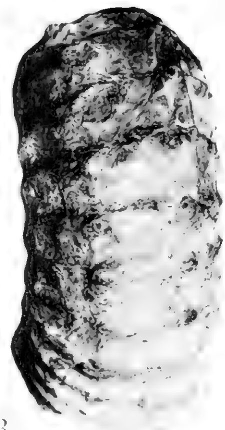

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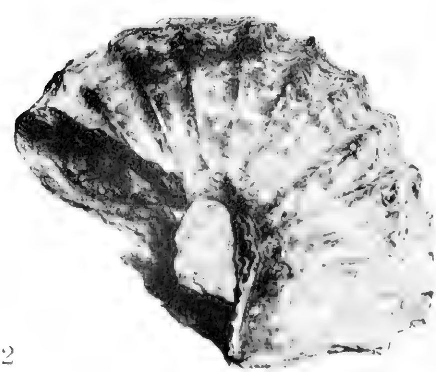

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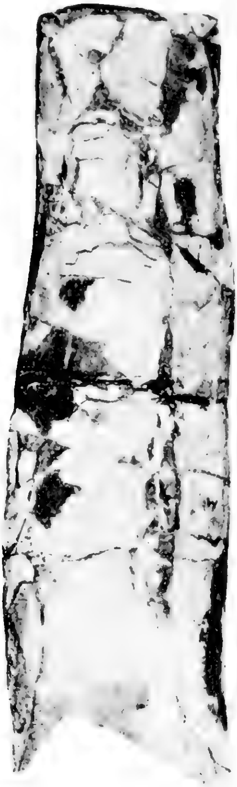
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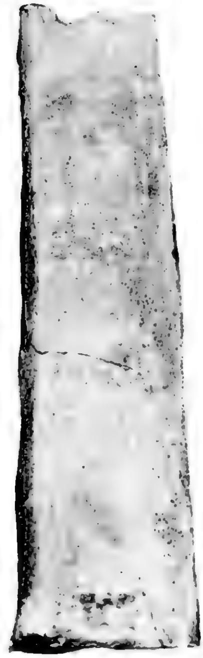
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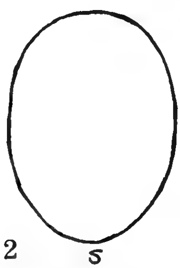

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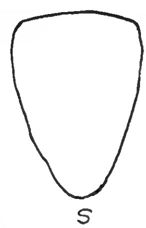

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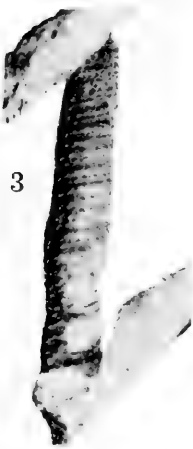
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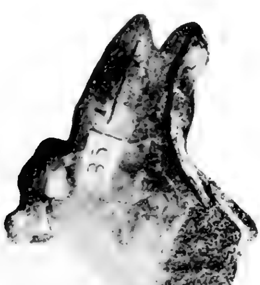
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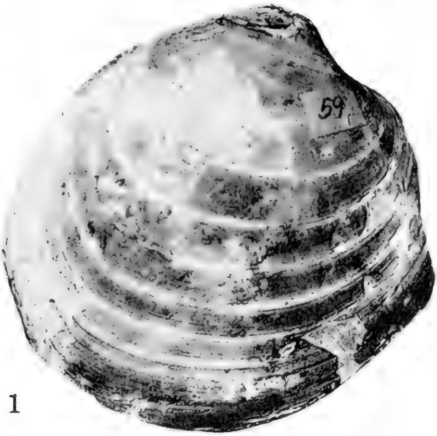

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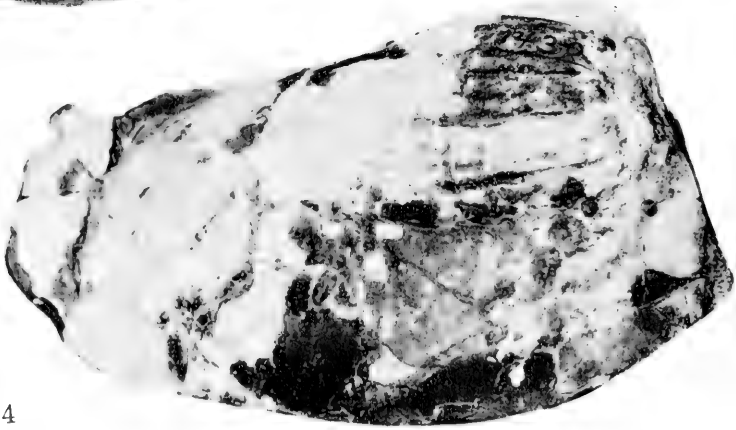
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**No. 2**

# A LIST OF THE BIRDS OF THE ATLIN REGION, BRITISH COLUMBIA*

BY

HARRY S. SWARTH

*Late Curator, Department of Ornithology and Mammalogy*
*California Academy of Sciences*

In the following pages there is presented a list of the birds of the Atlin region, British Columbia. Under each species there is given a brief statement of the manner of occurrence and all available migration dates, nothing more. A bare list of this nature requires justification, and it is found here in the fact that this region is far removed from any place in North America whence similarly extended series of observations have been recorded. I believe that this list will be useful in any future generalizations on the distribution and migrations of North American birds. There are many important conclusions and implications to be drawn from the manner of occurrence of certain species in this region, and these I may hope to present at some future time. There are certain species here listed, the classification of which is debatable, and where my treatment of these differs from current usage. I will endeavor to present my views at some length elsewhere, as cannot be properly done in this place. There are 166 species and subspecies here listed upon a satisfactory basis of identification, plus two (Cormorant and Great Blue Heron) that are uncertain. An asterisk preceding a name indicates one specimen or more collected.

Attention should be drawn to dates of arrival in the spring of the many species of water birds. This is dependent upon the thawing of the lakes, which may vary considerably through the years. Many of these species occur on the nearby coast of southeastern Alaska, where they may usually be found at an earlier date than inland, many of them through the winter. Some ducks are known to come

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directly inland from the coast, but others, and most of the waders, I believe, come from the southeast. Anyway, swimmers and waders may be looked for just as soon as a little open water or a stretch of snow-free sandbar appears, and dates of arrival will consequently vary as do the seasons.

The town of Atlin, in extreme northwestern British Columbia, has served as a center for my observations. Descriptive details of the region, from the standpoint of ornithological study, I have presented elsewhere (Swarth, 1926). I have here included also such information as was available from the surrounding region, including the inland slope of the White Pass, and Carcross, Yukon Territory, to the west, and as far as Lake Teslin to the east, an area roughly one hundred miles square. The appended bibliography includes only the publications known to me dealing with the local birds from a regional standpoint. Dr. L. B. Bishop (1900) was probably the first to report upon birds from this region, and this was only from marginal localities, in the White Pass and at Caribou Crossing (Carcross), while en route to the lower Yukon. F. Kermode and E. M. Anderson (1914) and Anderson (1915) made the first important collections about Lake Atlin. My own field work has been as follows: May 21 to September 24, 1924; June 16 to September 19, 1929; July 1 to October 23, 1931; March 27 to September 11, 1934. Major Allan Brooks, who accompanied me in 1924, made valuable observations at Log Cabin, in the White Pass, in August of that year. In the spring of 1930 Mr. Ronald M. Stewart, of the British Columbia Provincial Police, was stationed at Atlin, and has been there since that time. His keen interest in birds, which had already resulted in important additions to the collection of the Provincial Museum, inspired enthusiastic collecting in his new post. My own subsequent visits to Atlin have been rendered infinitely more profitable through his whole-hearted coöperation, and he has generously allowed me, too, the free use of his collection and note-books in compiling this list. Two species new to British Columbia, Hudsonian Godwit and White-rumped Sandpiper, were collected by him at Atlin, and, as will be seen, he has made many important records. Mr. W. T. Irvine, of the Royal Canadian Mounted Police, stationed at Nisuttlin Bay, Teslin Lake, has collected specimens for Stewart, and has obtained some unexpected records. His post is in Yukon Territory, a few miles north of the British Columbia boundary.

My work at Atlin was only possible through the generous privileges and assistance received year after year from the British Columbia Game Commission and from the National Parks office of the Department of the Interior, Ottawa, for which I wish here to express my appreciation. Various museums and individuals have assisted me in one way or another in the problems that arose, but I wish especially to acknowledge the opportunities I have had of examining the Atlin collections in the Provincial Museum, Victoria.

***Gavia immer.** Common Loon. Summer resident in small numbers. Most commonly seen in July and August. Latest noted: September 23, 1931. No observations for May, when the species may be assumed to arrive.

**Gavia arctica pacifica.** Pacific Loon. Transient, irregularly and in small numbers. Reported at Carcross, May 22, 1924; Atlin, June 23-24, 1924; July 30, 1931; June 1, 1934. Not known to nest in the region.

**Gavia stellata.** Red-throated Loon. A transient, of rare and irregular appearance. Exact records: June 20, 1924; July 24 and October 5, 1931; June 1, 1934.

***Colymbus grisegena holboelli.** Holboell Grebe. Summer resident. Earliest arrivals: May 28, 1924; May 24, 1934. Last seen: September 24, 1924.

***Colymbus auritus.** Horned Grebe. Summer resident. Earliest arrivals: May 8, 1931; May 9, 1933; May 11, 1934. Last seen: October 24, 1931. Newly hatched young, July 18, 1924.

[**Phalacrocorax auritus?** Cormorant. A cormorant of some kind was seen by Stewart on Lake Atlin, May 29, 1930. Indians have described to Stewart waterbirds seen by them at the south end of Lake Atlin and at Lake Teslin, that were apparently cormorants. The species that I would expect to see here is *P. auritus*; the occurrences, of stragglers from the east.]

[**Ardea herodias?** Great Blue Heron. Mr. W. T. Irvine told me that in the summer of 1933 a Teslin Indian had reported to him the sight of two strange birds on the shore of Teslin Lake, birds that the Indian then identified as Great Blue Herons, from the colored plate in Taverner's "Birds of Western Canada." I know of no occurrences near Atlin. Herons that I saw on the upper Stikine River some two hundred miles to the southward, I assumed to be of the coastal subspecies, *fannini*, stragglers that had wandered up the river. Great Blue Herons that reached Teslin would be likely to have strayed from the Mackenzie basin to the eastward.]

**Cygnus columbianus.** Whistling Swan. A fairly regular spring migrant. Dates of arrival: April 13, 1931; May 5, 1933; April 24, 1934; April 29, 1935. On the 1934 date a flock of about two hundred birds passed overhead. I have no fall records.

**Branta canadensis leucopareia.** Lesser Canada Goose. Large geese of this species, presumably of the subspecies *leucopareia*, migrate commonly along the Teslin drainage, but they are extremely rare at Atlin. At Gladys Lake (perhaps forty miles northeast of Atlin), September 8, and at Teslin Lake, September 10-13, 1924, these geese were present in great numbers. Two small flocks flying high overhead, on September 21, 1924, and October 14, 1931, respectively, are all I have seen at Atlin.

*__Branta canadensis minima.__ Cackling Goose. A small flock alighted in a slough at Atlin, May 15, 1931, and Stewart collected one specimen. A crippled bird from the same flock remained in the slough, where I shot it later in the summer. This is my only record from the Atlin region, which is probably outside the normal migration route of this goose.

**Anser albifrons.** White-fronted Goose. Single birds seen at Atlin, April 29 and May 4, 1931 (R. M. S.). No other records.

*__Chen hyperborea hyperborea.__ Lesser Snow Goose. Two birds seen, one collected, May 9, 1932 (R. M. S.); one bird collected, May 5, 1933 (R. M. S.); all in the immediate vicinity of Atlin. No other records.

**Anas platyrhynchos platyrhynchos.** Mallard. Common summer resident. First arrivals: April 29, 1933; April 21, 1934; April 22, 1935. Common through September; last recorded October 5 (1931), but probably remains to a later date.

**Mareca americana.** Baldpate; Widgeon. No nests have been found or young birds seen, but a few adults are present through the summer. A common migrant. Earliest seen, April 20, 1934; April 25, 1935.

**Dafila acuta tzitzihoa.** American Pintail. Abundant summer resident. Earliest arrival: April 23, 1934; April 11, 1935. Latest seen: October 3, 1931. Newly hatched young seen June 23, 1924.

**Nettion carolinense.** Green-winged Teal. Common summer resident. Earliest arrivals: April 30, 1933; April 20, 1934; April 22, 1935. Last seen October 5, 1931. A brood of newly hatched young seen July 11, 1934.

*__Querquedula discors.__ Blue-winged Teal. Although the species has not before been found breeding nearly so far north as this, nevertheless, Stewart has seen Blue-winged Teal at Atlin regularly each summer since he has been there. Together we have seen broods of downy young in 1931 and 1934. Earliest arrival noted, May 27, 1934; and I have a specimen collected September 9, 1931. Of regular occurrence but not common.

**Spatula clypeata.** Shoveller. Not common, though of yearly occurrence. Probably breeds, as a few birds may be seen through the summer. Earliest arrivals: May 14, 1934. Latest seen: September 11, 1913 (E. M. Anderson).

**Nyroca valisineria.** Canvas-back. Single birds seen July 12, 1914 (E. M. Anderson), April 30, 1931 (R. M. S.), and May 9, 1933 (R. M. S.).

**Nyroca marila.** Greater Scaup Duck. A transient, of uncertain status due to its close resemblance to *N. affinis*. Stewart regards it as of fairly regular occurrence in migration, but has collected no specimens. (See Brooks, 1927, p. 112.)

***Nyroca affinis.** Lesser Scaup Duck. A common summer resident. Earliest arrivals: May 3, 1933; May 5, 1934. Last seen, October 17, 1931. Sets of eggs were collected July 2, 1924.

**Glaucionetta clangula americana.** American Golden-eye. A migrant, of regular occurrence in spring but in small numbers. Earliest arrival, April 28, 1934; May 6, 1935.

***Glaucionetta islandica.** Barrow Golden-eye. Summer resident; the most abundant and most generally distributed species of duck in this region. First arrivals: April 29, 1933; April 23, 1934; April 27, 1935. Last recorded October 21 (1931), but probably remains to a later date. First downy young were seen July 3, 1924, July 6, 1931, and July 6, 1934.

**Charitonetta albeola.** Buffle-head. A regular and fairly abundant migrant. Seen at Carcross, May 22-24, 1924. Seen at Atlin, April 22 to May 16, 1934; October 7-19, 1931.

***Clangula hyemalis.** Old-squaw. A migrant, irregularly of great abundance. Seen May 10, 1932; May 10 to June 19, 1934 (in great numbers the latter part of May); September 16, 1931. Found breeding at Log Cabin, in the White Pass, about fifty miles east of Atlin (Brooks, 1927, p. 112), and may prove to do so on Atlin and Tagish lakes.

***Histrionicus histrionicus.** Harlequin Duck. A fairly common migrant. Breeds in small numbers throughout the region, along rushing streams and apparently only above the 3,000 foot level. Earliest arrival, May 14, 1934. Last seen, October 4, 1931.

***Melanitta deglandi.** White-winged Scoter. An abundant migrant. The White-winged Scoter breeds regularly (from ten to twenty pairs) about Lake Como, three miles northeast of Atlin, but I have not found it nesting elsewhere in the region. This body of water (about a mile long) is peculiar in that it has no stream flowing in or out, and contains no fish. Dates of arrival of the White-winged Scoter: Carcross, May 24-26, 1924; Atlin, May 17, 1934. Latest seen, October 21, 1931. Broods of newly hatched young appeared July 20, 1924, July 24, 1929, and July 25, 1931.

**Melanitta perspicillata.** Surf Scoter. A regular and fairly common migrant. Seen May 8, 1931; May 11-24, 1934. In late summer: July 29 and August, 1914; July 21, 1924.

**Lophodytes cucullatus.** Hooded Merganser. One record, of an adult male seen near Atlin, June 17, 1924.

**Mergus merganser americanus.** American Merganser. A migrant, of regular occurrence in the spring but in small numbers. Dates of record: Carcross, May 24, 1924. Atlin, May 2, 1931; April 29, 1933; April 22, 1934; September 30, 1931. A breeding record for this species at Atlin (Anderson, 1915, p. 9) properly pertains to *M. serrator*.

***Mergus serrator.** Red-breasted Merganser. Fairly common summer resident. Earliest arrival, May 16, 1934. A nest with eight eggs was collected by Mr. Wilson C. Hanna and myself on Third Island, Atlin Lake, July 16, 1931. A young bird unable to fly was collected on Surprise Lake, September 15, 1924.

***Astur atricapillus atricapillus.** Eastern Goshawk. Presumably nests in the region, as a few Goshawks may be seen through the summer. Most abundant on migration, in August and September. Earliest arrival noted: April 15, 1934. Latest seen: November 6, 1931.

***Circus hudsonius.** Marsh Hawk. A common migrant. The Marsh Hawk should nest here, of course, but I know of no midsummer occurrences, even, of the species. Spring arrivals: April 27, 1932; April 12 to May 14, 1934; April 29, 1935. Fall: August 26 to September 21, 1924; September 13-19, 1931.

**Pandion haliaëtus carolinensis.** Osprey. Uncommon summer resident. Nests, old and new, may be seen at various points around Atlin Lake. I have seen Ospreys as late as September 13 (1931).

***Falco rusticolus candicans.** Gyrfalcon. A rare summer resident at high altitudes. In late July and early August, 1924, Gyrfalcons were seen on a high ridge west of Otter Creek, and on July 31 Allan Brooks collected an adult female. In other years since then I have had occasional glimpses of what appeared to be Gyrfalcons, but only once or twice when I could feel reasonably certain of their identity. Stewart has one that was shot in September, 1934.

**Falco peregrinus anatum.** Duck Hawk. Probably a rare summer resident. The only data obtained relate to the sight of occasional birds from Tagish Lake to Teslin Lake, at widely scattered intervals between the dates May 27 and September 12.

***Falco columbarius columbarius.** Pigeon Hawk. Presumably nests in the region, but I have no information to this effect and record of only an occasional bird seen in midsummer. A regular migrant, rare in the spring, of almost daily occurrence in late August and early September. Dates of arrival: April 23, 1931; April 19, 1934. Latest seen: October 11, 1931.

The above statements cover both *Falco columbarius columbarius* and the so-called Black Merlin, *F. c. suckleyi*. The two names may represent no more than two color phases, which occur in the Atlin region in about equal abundance. *F. c. bendirei* I look upon as a synonym of *F. c. columbarius*.

***Accipiter velox.** Sharp-shinned Hawk. Abundant on migration. Presumably nests in the region as a few birds are seen at intervals through the summer. Dates of arrival: April 18, 1933; April 20, 1934. Latest seen: October 19, 1931.

***Buteo borealis harlani.** Harlan Hawk. Fairly common summer resident, nesting in the lowland forest. Earliest arrival: April 1, 1934. Latest seen: September 21, 1924. In two nests under observation the eggs had been laid about the first week in June.

***Archibuteo lagopus s.johannis.** American Rough-legged Hawk. Definitely identified only in the fall migration of 1931. An adult female was collected on September 19, and one or two hawks supposed to be of this species were seen later in the same month. In the dark phase the Rough-legged Hawk is sufficiently like the Harlan Hawk to make recognition uncertain.

***Aquila chrysaëtos.** Golden Eagle. Fairly common and probably resident through the year. I have examined several nests that appeared to have been recently vacated, built in low bluffs, one at the level of Lake Atlin, others above timber-line. A Golden Eagle was seen soaring overhead above the summit of the White Pass, March 27, 1934, where mid-winter conditions still prevailed.

***Haliaeetus leucocephalus alascanus.** Northern Bald Eagle. Of uncommon occurrence east of the Coast Range, though a few pairs nest about Lake Atlin, and probably about other large lakes. A nest with downy young was found near the Warm Springs about fifteen miles south of Atlin, July 4, 1914 (E. M. Anderson). The species may be resident throughout the year. I saw two Bald Eagles side by side on a tree-top overlooking the winter portage between lakes Tagish and Atlin, March 28, 1934, when the lakes, of course, were frozen over and the country deep with snow.

***Falco sparverius sparverius.** Eastern Sparrow Hawk. A common summer resident, mostly in the lowlands. Earliest date of arrival, April 22, 1934. Latest fall record, September 20, 1931.

***Dendragapus obscurus richardsoni.** Richardson Grouse; Blue Grouse. Permanent resident. Nests mostly in balsam fir woods about at timber-line; sometimes appears at low levels in the late summer. About Atlin the species was fairly abundant in 1924, it was almost totally absent in 1929, and has been slowly recovering numbers since that time. Broods of young appear about the middle of July.

*__Canachites canadensis osgoodi.__ Alaska Spruce Grouse; Fool Hen. Permanent resident of the spruce forests in the valleys and foot-hills. Nests even on islands in Lake Atlin. Reported as abundant in 1914 (E. M. Anderson); in 1924 it was not common though seen on many occasions; in 1929 it was almost totally absent; in 1931, decidedly abundant; in 1934 in fair abundance. The first young are hatched about the last week in June.

*__Bonasa umbellus umbelloides.__ Gray Ruffed Grouse; Willow Grouse. Permanent resident in the valleys, almost entirely in "poplar" (quaking aspen) woods. In 1914 Ruffed Grouse were reported as not common (E. M. Anderson); in 1924 they were not common; in 1929 almost totally absent; in 1931, abundant; in 1934, in fair abundance.

*__Lagopus lagopus albus.__ Willow Ptarmigan. Permanent resident in varying numbers. Nests in willow-grown bottom lands at about 3,000 to 4,000 feet elevation, between the lowland forests and the timberless summits. Of common occurrence in winter throughout the lowlands; seen in the town of Atlin as late as April 4 (1934). Nests with eggs were found June 26, 1914 (E. M. Anderson), and June 30, 1924. The Willow Ptarmigan was abundant in 1914 (E. M. Anderson), in great abundance in 1924; rare almost to extinction in 1929; increasing in 1931; and numerous in the fall of 1934.

*__Lagopus rupestris rupestris.__ Rock Ptarmigan. Permanent resident locally at high altitudes. Fairly numerous in 1924, extremely rare in 1929, and slowly increasing since that time, as observed in 1931 and 1934. Not known to visit the lowlands in winter.

*__Lagopus leucurus leucurus.__ White-tailed Ptarmigan. Locally known as "Rock Ptarmigan." Permanent resident in small numbers on the highest peaks and ridges, usually in exposed, rocky localities. Descends to the valleys in winter. A nest with eight eggs found June 15, 1934.

**Grus canadensis.** Little Brown Crane. Migrating flocks seen May 22 and 25, 1931 (R. M. S.). No other records.

**Fulica americana.** American Coot. Single birds seen April 27 and September 15, 1931 (R. M. S.). On April 25, 1934, one was reported by an Indian, who gave an accurate description of what to him was a strange bird.

***Charadrius semipalmatus.** Semipalmated Plover. Usually an abundant summer resident. First arrivals: May 14, 1930; May 6, 1933; May 11, 1934. Leaves about the end of August; last seen August 21, 1924. In 1934 the species was present in very small numbers.

**Oxyechus vociferus vociferus.** Killdeer. An irregular summer resident. Seen about Atlin from May 28 to July 10, 1924; single birds on June 26, 1929, and May 10, 1932; in 1934 the first arrived on April 21 and a good many were seen thereafter through the summer; in 1935 two arrived on May 2. Not seen at all in 1930, 1931, and 1933.

***Pluvialis dominica dominica.** American Golden Plover. A rare migrant, reported by Stewart as follows: May 4, 1932, two males collected; May 16, 1933, birds seen; August 5, 1934, birds seen; September 23, 1934, one bird shot at about 5,000 feet elevation above Wright Creek; May 19, 1935, a flock of twenty-eight birds.

***Squatarola squatarola.** Black-bellied Plover. A rare migrant, thus far recorded as follows: September 28, 1913, three birds seen (E. M. Anderson); September 29, 1933, one bird seen (R. M. S.); October 1, 1933, a male bird collected (R. M. S.).

***Aphriza virgata.** Surf-bird. One record for this general region, of a bird collected by Allan Brooks at Carcross, May 27, 1924.

***Arenaria melanocephala.** Black Turnstone. One record, of a single bird, immature (now in Stewart's collection), collected by W. T. Irvine at Teslin in the late summer of 1933. This is the only instance known to me of the occurrence of this species away from salt water.

***Gallinago delicata.** Wilson Snipe. Generally an abundant summer resident. In small numbers in 1934. Dates of arrival: May 2, 1930; April 27, 1931; May 2, 1933; April 18, 1934.

***Phaeopus hudsonicus.** Hudsonian Curlew. I saw a mounted Hudsonian Curlew that was shot at Atlin about the middle of May, 1924; Stewart has observed the species there May 31, 1931, and June 3, 1933; and W. T. Irvine shot two male birds at Teslin May 30, 1934.

***Actitis macularia.** Spotted Sandpiper. Common summer resident. Migration dates: May 22 to September 15, 1924; May 24, 1934.

***Tringa solitaria.** Solitary Sandpiper. Common migrant. A few Solitary Sandpipers assuredly nest in the region; for though we have found no nests or any very young birds, females have been collected that contained partly formed eggs. Migration dates—Spring: Carcross, May 25, 1924. Atlin, May 2, 1931; May 12, 1933; May 10, 1934. Last seen: August 6, 1924; August 6, 1934.

***Heteroscelus incanus.** Wandering Tattler. In all probability a few Wandering Tattlers nest in suitable localities throughout this general region. A single bird was collected by Allan Brooks at Carcross, May 25, 1924. Stewart collected the male of a pair near the head of McKee Creek (about ten miles south of Atlin), June 19, 1932. In my company he collected a male that was approaching breeding condition, June 5, 1934, on a reef in the middle of Atlin Lake.

***Totanus melanoleucus.** Greater Yellow-legs. A migrant, apparently in very small numbers, though of this it is difficult to be sure, due to the close resemblance of this species to the abundant Lesser Yellow-legs. One specimen collected April 23, 1934 (R. M. S.). There is a sight record for May 2, 1932 (R. M. S.), and of others seen in May, 1934, by Stewart and Swarth together.

***Totanus flavipes.** Lesser Yellow-legs. Common summer resident. Besides the nesting population, many non-breeding birds remain in flocks through the summer. Spring arrivals: May 3, 1930; May 2, 1933; May 5, 1934; May 3, 1935. Last seen: August 14, 1914 (E. M. Anderson); August 14, 1924; August 19, 1934. Newly hatched young collected June 17, 1924. In 1931 the Lesser Yellow-legs was much scarcer than during other years.

***Arquatella ptilocnemis couesi.** Aleutian Sandpiper. An immature female that was collected by Stewart at Atlin, October 29, 1932, is, so far as I know, the only recorded occurrence of this sandpiper away from salt water.

***Pisobia melanotos.** Pectoral Sandpiper. A common migrant. Migration dates: Spring—June 4, 1924 (last spring migrant); May 12, 1930; May 9, 1933; May 12 to May 23, 1934. Fall—September 9 to October 4, 1931; August 5, 1934.

***Pisobia fuscicollis.** White-rumped Sandpiper. One record, a male bird collected by Stewart at Atlin, May 16, 1931. This is the first recorded occurrence of the species in British Columbia.

***Pisobia bairdi.** Baird Sandpiper. A common migrant in the spring. So far not observed in the fall. Dates of passage: Carcross, May 22, 1924. Atlin, May 11, 1931; May 10 to 20, 1932; May 6, 1933; April 19 to May 13, 1934.

***Pisobia minutilla.** Least Sandpiper. A common migrant. Spring: Carcross, May 22, 1924. Atlin, May 9, 1930; May 12, 1933; May 11-16, 1934. Fall: June 29 to August 27, 1924; July 30, 1931; August 6-26, 1934.

**Pelidna alpina sakhalina.** Red-backed Sandpiper. A single bird seen May 21, 1930 (R. M. S.). Three seen, one secured, May 7, 1935 (R. M. S.).

***Limnodromus griseus scolopaceus.** Long-billed Dowitcher. Appears in small numbers during the spring migration. Dates of arrival: May 1, 1930; May 9, 1932. A single bird on May 14 was the only one seen in 1934.

***Ereunetes pusillus.** Semipalmated Sandpiper. A regular migrant in small numbers. Spring: May 18, 1930; May 18, 1931; May 18, 1933; May 12-21, 1934. South-bound: July 17, 1924; July 23, 1929; August 3, 1931; August 2, 1932; August 12-15, 1934. Teslin, September 12, 1924.

***Ereunetes maurii.** Western Sandpiper. Of extremely rare occurrence. Recorded by Stewart as follows: April 29, 1931, one bird seen; May 14, 1933, two birds seen; May 19, 1933, one bird, female, collected.

***Tryngites subruficollis.** Buff-breasted Sandpiper. A male bird collected by W. T. Irvine at Teslin June 1, 1934.

***Limosa haemastica.** Hudsonian Godwit. One occurrence: A single bird, male, was collected by Stewart at Atlin, May 6, 1932. This is the first record for this species in British Columbia.

***Crocethia alba.** Sanderling. One occurrence: A single bird, an immature female, was collected by Stewart at Atlin, August 28, 1931.

***Lobipes lobatus.** Northern Phalarope. A common migrant. There are reasons for suspecting that it may sometimes nest as far south as Carcross and Atlin. Migration dates: Spring arrivals, May 15, 1931; May 22, 1932; May 12, 1934. South-bound: July 21-September 1, 1924; July 18, 1929; July 26, 1934.

***Stercorarius pomarinus.** Pomarine Jaeger. A specimen of Pomarine Jaeger in the collection of R. M. Stewart was collected by W. T. Irvine on Lake Teslin, thirty miles north of the British Columbia boundary, in the summer of 1933. In view of the established identity of this bird, three Jaegers seen by Stewart on Lake Atlin in the summer of 1932, and one seen by myself on Lake Teslin, September 11, 1924 (recorded as *S. parasiticus*), may be assumed to have been of the same species.

***Larus argentatus smithsonianus.** Herring Gull. Common summer resident. Known to nest on islets in Lake Atlin, and may be assumed to do so in similar surroundings in other large lakes. First arrivals: April 29, 1933; April 29, 1934. Seen up to September 11 (1924); probably remains to a later date. Incomplete sets of eggs found June 5, 1934; fresh eggs, July 8, 1914.

*__Larus canus brachyrhynchus.__ Short-billed Gull. Common summer resident. Known to nest on islands in Lake Atlin, and may be assumed to do so elsewhere in this general region. First arrivals: May 7, 1932; May 3, 1933; April 22, 1934. Last seen, August 29, 1929.

*__Larus philadelphia.__ Bonaparte Gull. Common summer resident. Nests on islands in Lake Atlin and about small lakes on the mainland. First arrivals: May 7, 1930; May 5, 1933; May 6, 1934. Last seen: August 7, 1924; August 12, 1934. Sets of eggs were taken May 31 (1934), and July 4 (1929).

*__Sterna paradisaea.__ Arctic Tern. Common summer resident. Nests on islands in Lake Atlin and other large lakes. Earliest arrival: May 11, 1934. Latest seen: August 8, 1924; August 4, 1929; August 13, 1931. Fresh eggs were found June 5, 1934.

*__Zenaidura macroura marginella.__ Western Mourning Dove. A rare transient. Two specimens in Stewart's collection were collected by W. T. Irvine at Teslin, in October, 1933, a young male and an adult female, the latter on October 6. I have had the Mourning Dove described to me by several people, as having occurred in Atlin at different times. The two specimens examined are definitely of the subspecies *marginella*.

*__Bubo virginianus subarcticus.__ Great Horned Owl. A common resident, sometimes occurring in considerable abundance. On March 28, 1934, I saw at a mink farm on Tagish Lake the remains of about twenty-five Horned Owls that had been shot there during the preceding winter.

The Horned Owls of this region exhibit a wide range of color variation. A majority of the birds are of the dark mode that has received the name *leucomelas* (Bishop, Proc. Biol. Soc. Wash., 1931, vol. 44, p. 93), others are quite as pale as Alaskan examples of *subarcticus*. Both types may occur in the same brood of young (see Swarth, 1926, p. 114). The proper nomenclatural usage under the circumstances is a question.

*__Surnia ulula caparoch.__ American Hawk Owl. Probably resident, though no winter records are available. During the summer months in fluctuating numbers from year to year. "Common" in September, 1913 (Kermode). "Tolerably abundant" in the summer of 1914. Parent birds with downy young collected June 14 (E. M. Anderson). In 1924 I saw one bird several times at the same place during the last week in May; and I saw a good many between August 19 and September 19. In 1929 I saw none; in 1931 a single bird on August 12. In 1934 I saw none, but heard of one that was shot nearby.

***Glaucidium gnoma,** subsp. Pygmy Owl. Just one record, of a female collected by myself September 16, 1931, on the Lake Como road, about two miles from Atlin. I believe that this is the northernmost recorded occurrence of this species.

***Scotiaptex nebulosa nebulosa.** Great Gray Owl. In 1924 I saw a mounted Great Gray Owl in Atlin that I was told had been shot nearby. My only other record is of an adult female collected near the town July 28, 1929 (Swarth, 1930, p. 216).

**Asio flammeus flammeus.** Short-eared Owl. This species should nest, and not uncommonly, in this general region, but, whatever the reason, I have few definite records of occurrence, of a bird seen October 2, 1931, and of others through December, 1934.

***Cryptoglaux funerea richardsoni.** Richardson Owl. Stewart has three specimens collected at or near Atlin in 1932, on February 10, February 26, and March 11, respectively. These are our only records.

***Cryptoglaux acadica acadica.** Saw-whet Owl. Stewart has two specimens collected in buildings in Atlin, on January 23, 1932, and February 20, 1932, respectively. These are our only records.

***Chordeiles minor minor.** Eastern Nighthawk. Common summer resident in the lowlands. Migration dates: Arrivals, June 12, 1924; July 3, 1934. Latest seen, September 6, 1924; August 24, 1929; September 1, 1931. Sets of eggs were found during the first week in July. The Nighthawk was last heard "booming" on July 25.

***Selasphorus rufus.** Rufous Hummingbird. Of rare occurrence in summer; may be supposed to breed in the region but no nest has been found. Two or three birds are as many as may be expected to be seen in a summer. Dates of occurrence, all from the immediate vicinity of Atlin, range from May 12 (1934) to August 20 (1931).

**Megaceryle alcyon caurina.** Western Belted Kingfisher. A summer resident, of regular occurrence but in distinctly small numbers. Earliest date of arrival, May 14 (1934).

***Colaptes auratus borealis.** Northern Flicker. Fairly common summer resident in the lowlands. Migration dates: Arrivals, May 11, 1931; May 3, 1933; May 13, 1934. Latest seen: September 16, 1929; September 10, 1931.

***Dryobates villosus septentrionalis.** Northern Hairy Woodpecker. Resident but always extremely rare. In 1924 I saw three birds, on July 6, July 7, and August 22, respectively. In 1929, one was seen on July 19, two on August 19, and one each on August 24 and September 8. In 1931, one was seen on July 28, one on September 9.

In 1934, during field observations extending from March 28 to September 10, not one was seen. Stewart has specimens collected January 5 and December 31, 1931, demonstrating mid-winter occurrence.

***Dryobates pubescens nelsoni.** Nelson Downy Woodpecker. Of about the same status as the Hairy Woodpecker. Probably resident in poplar woods (though we have no midwinter records), but always extremely rare. I have records of birds seen or collected in 1924, 1929, and 1931, on scattered dates ranging from June 8 to September 8. A nest with young was found July 9, 1929.

***Picoïdes arcticus.** Arctic Three-toed Woodpecker. Resident in small numbers; in lesser numbers than the Alaska Three-toed Woodpecker. Both species are most likely to be found in recently burned woods. A record for March 11, 1932, indicates residence through the winter.

***Picoïdes tridactylus fasciatus.** Alaska Three-toed Woodpecker. Resident, in fluctuating numbers during different years and never at all commom. A specimen collected January 7, 1932.

***Sayornis saya yukonensis.** Northern Say Phoebe. Common summer resident. Nests almost exclusively about human habitations, occupied or abandoned. Dates of arrival: May 10, 1930; May 11, 1934. Latest seen: Teslin, September 10, 1924; Atlin, September 2, 1929.

***Empidonax flaviventris.** Yellow-bellied Flycatcher. One record: An adult male collected at Pike River (south end of Atlin Lake), August 3, 1914 (E. M. Anderson).

***Empidonax trailli trailli.** Alder Flycatcher. Common summer resident in willow thickets in the lowlands. Dates of arrival: June 12, 1924; June 6, 1934. Latest seen, August 29, 1924; August 31, 1929.

***Empidonax hammondi.** Hammond Flycatcher. Generally an abundant summer resident, as observed in 1924, 1929, and 1931. In 1934 it was extremely rare. Dates of arrival: June 1, 1924; May 17, 1934. Latest seen, August 31, 1924. Inhabitant of poplar woods.

***Empidonax wrighti.** Wright Flycatcher. A summer resident. In 1924 three specimens were collected, all at high altitudes and all that were seen. In 1929 and in 1931 the species was not observed at all. In 1934 it was frequently seen, and in the poplar woods of the lowlands, where, that year, it seemed to replace the nearly absent Hammond Flycatcher. First arrival: May 22, 1934. Latest seen: August 17, 1924; August 17, 1934.

***Myiochanes richardsoni richardsoni.** Western Wood Pewee. Common summer resident. Dates of arrival: Carcross, May 22, 1924; Atlin, May 24, 1934. Latest seen: Atlin, August 28, 1924; August 26, 1929; September 1, 1931.

***Nuttallornis mesoleucus.** Olive-sided Flycatcher. Of regular occurrence in summer but in small numbers. Dates of arrival: Carcross, May 26, 1924; Atlin, May 17, 1934. Last seen, Atlin, August 28, 1924; September 2, 1931. A nest with four eggs was collected June 21, 1914 (E. M. Anserson).

***Otocoris alpestris arcticola.** Pallid Horned Lark. Common summer resident on the ridges above timber-line. A few migrants visit the lowlands in the spring; I have never known any to do so in the fall. Arrivals at Atlin: May 1, 1930; April 18, 1933; April 19 to May 5, 1934; April 12, 1935. Latest seen: September 13, 1931.

***Tachycineta thalassina lepida.** Violet-green Swallow. Common summer resident, nesting mostly about houses and in bird boxes in town. Earliest arrivals, May 1, 1933; April 21, 1934; May 2, 1935. The southward migration begins during the last week in July. Latest date of record, September 1, 1924.

**Iridoprocne bicolor.** Tree Swallow. Common summer resident. The only nesting pairs that I have seen have occupied bird boxes in town, but in late July flocks of young birds gathered in preparation for southward migration are of such large numbers as to indicate a numerous breeding population in the surrounding region. Earliest arrival noted May 12, 1934. The Tree Swallows are gone by the middle of August.

**Riparia riparia riparia.** Bank Swallow. Summer resident, in varying numbers from year to year but generally rather scarce. In 1934 Bank Swallows were present in large flocks in the town of Atlin, from June 1 to September 3, but I was unable to find where they were nesting. There are no sand banks in this vicinity such as the species usually occupies.

**Hirundo erythrogaster.** Barn Swallow. An extremely abundant summer resident, nesting entirely about houses and other structures. Migration dates: Arrivals, May 26, 1924 (Carcross); May 14, 1934 (Atlin). Departures, September 1, 1924; September 7, 1931; September 3, 1934.

**Petrochelidon albifrons albifrons.** Northern Cliff Swallow. An extremely abundant summer resident, building nests, so far as I know, entirely upon man-made structures. Migration dates: Arrivals, May 26, 1924 (Carcross); May 21, 1934 (Atlin). Latest seen, August 16, 1924; August 5, 1929; August 12, 1934.

*****Perisoreus canadensis canadensis.** Canada Jay. Common resident of wooded country up to the upper tree limit.

*****Pica pica hudsonia.** American Magpie. Occupied nests without eggs were found at Carcross during the last week in May. At Atlin the Magpie occurs commonly in the fall; it is of occasional occurrence through the winter and in early spring. Seen at Gladys Lake (forty miles northeast of Atlin), September 8, 1924; at Atlin, September 19, 1924; September 10, 1929; September 17, 1931. Latest spring date at Atlin, April 12, 1934.

**Corvus corax tibetanus.** Northern Raven. Not known to nest anywhere in this region. An irregularly abundant transient in the fall, occurs occasionally through the winter, and very rarely a stray Raven is seen in midsummer. In 1924 I saw several at Teslin, September 12. About Atlin, Ravens were seen "after August 15, 1914" (E. M. Anderson). I saw one at Atlin, April 27, 1934, and one on June 3, 1934.

*****Nucifraga columbiana.** Clark Nutcracker. Stewart has two specimens, one a male collected at Atlin, October 28, 1931, the other collected on the upper Taku River in December, 1931. These are the only records for the region.

*****Penthestes atricapillus septentrionalis.** Long-tailed Chickadee. Resident in poplar woods, abundant in summer, rare in midwinter.

*****Penthestes gambeli grinnelli.** Grinnell Chickadee. Only one record, of an adult male collected June 12, 1924. This was in the lowlands about two miles north of the town of Atlin. It is the northernmost point at which the species has been found.

*****Penthestes hudsonicus columbianus.** Columbian Chickadee. Resident of spruce woods everywhere below timber-line. Common in summer, rare in mid-winter.

*****Sitta canadensis.** Red-breasted Nuthatch. Of rare occurrence. Presumably a few pairs breed in the region, as it is occasionally seen during the summer. Appears with fair regularity, always in small numbers, in late summer. Latest date of observation, August 31 (1924).

**Cinclus mexicanus unicolor.** Dipper. Resident the year through, but in small numbers. During the breeding season pairs occur at wide intervals along mountain streams. Through the winter Dippers are restricted to the few places where a little open water persists, often at the outlets of lakes.

*****Turdus migratorius migratorius.** Eastern Robin. A common summer resident, about human dwellings, in lowland woods, and above timber-line where the sheltering, semi-prostrate balsam thickets extend. Migration dates: First arrivals, April 25, 1931; April 26, 1932; April 30, 1933; April 20, 1934; May 2, 1935. Latest seen, October 4, 1931.

*__Ixoreus naevius meruloides.__ Northern Varied Thrush. A common migrant of regular occurrence. Spring: April 26, 1931; April 24 to May 7, 1934. Fall: September 5-21, 1924; September 1-16, 1929; September 1 to October 4, 1931; arrived September 3, 1934.

*__Hylocichla guttata guttata.__ Alaska Hermit Thrush. Ordinarily a common summer resident in the lowlands. Migration dates: First arrivals, May 15, 1930; May 10, 1932; May 7, 1934. Latest seen: September 19, 1924; September 8, 1929. Almost totally absent in 1934.

*__Hylocichla guttata faxoni.__ Eastern Hermit Thrush. A rare migrant in late summer. Two specimens were collected, on August 23, 1924, and September 10, 1931, respectively. One intermediate between *faxoni* and *guttata* was taken August 26, 1929.

*__Hylocichla ustulata swainsoni.__ Olive-backed Thrush. Ordinarily a common summer resident, restricted mostly to poplar woods. Migration dates: First arrivals, May 24, 1931; May 21, 1934. Latest seen, August 29, 1924. The species was almost totally absent in 1934.

*__Hylocichla minima aliciae.__ Gray-cheeked Thrush. A rare migrant. Not known to breed in the region though one was collected June 13, 1914 (E. M. Anderson). A specimen at hand was collected September 1, 1929.

*__Sialia currucoides.__ Mountain Bluebird. Common summer resident of the lowlands, mostly about human habitations. Nearly everyone puts up nesting boxes for the Bluebirds. Migration dates: First arrivals, April 13, 1931; April 22, 1933; April 13, 1934; April 16, 1935. Latest seen, September 24, 1924.

*__Myadestes townsendi.__ Townsend Solitaire. Fairly common summer resident, in the lowlands and in suitable places above timberline, at least up to 4,500 feet. Earliest date of arrival, April 30, 1934. Latest seen: September 1, 1924; September 1, 1929.

*__Regulus satrapa olivaceus.__ Western Golden-crowned Kinglet. Only two records, of one bird seen May 29, 1924, and of one bird collected August 24, 1931.

*__Corthylio calendula calendula.__ Eastern Ruby-crowned Kinglet. Fairly common summer resident, mostly in spruce woods. Migration dates: First arrivals, April 17, 1930; April 26, 1931; April 30, 1933; April 18, 1934. Latest seen: October 4, 1931.

*__Anthus rubescens.__ American Pipit. Breeds commonly on open slopes and ridges above timber-line, mostly above 4,000 feet. Of common occurrence in the lowlands during migration. Migration dates at Atlin: In 1924, August 26 to September 23 (probably remained much later). In 1931, first arrival April 26; September 20 to October 14. In 1933, first arrival April 20. In 1934, spring: April 18 to May 22. In 1935, arrived April 22. Late summer occurrence in the lowlands is generally about from September 1 to October 15.

*__Bombycilla garrula pallidiceps.__ Bohemian Waxwing. As a rule an abundant summer resident. So reported in 1914 (E. M. Anderson), and I found it so in 1924, 1929 and 1931. In 1934 the species was almost totally absent. Earliest arrivals noted, April 18, 1934 (the only flock seen that year). Latest date of observation, October 19, 1931. Probably the arrival and departure of the waxwing is governed by weather conditions, with consequent availability of berries, more than is the case with most birds, but the absence of the species during the summer of 1934 can not be explained thus.

*__Lanius borealis.__ Northern Shrike. A regular migrant, most abundant in the fall, and a rare summer resident. An occasional breeding pair may be found near the upper limit of timber at about the 3,500 foot level. Earliest arrivals in spring: April 21, 1933; April 18, 1934; April 20, 1935. Southward migration mostly in October, but some individuals may linger much later, until driven south by severe weather. Specimens collected by Stewart December 1 and 5, 1931.

*__Vireo gilvus swainsoni.__ Western Warbling Vireo. Of irregular and extremely rare occurrence in summer, presumably nesting; always in poplar or willow woods in the lowlands. In 1924 Warbling Vireos were seen or heard occasionally from June 8 to August 17; in 1929, during the last week in June. Not observed in 1931. In 1934 seen or heard several times from May 18 to June 13.

*__Vermivora peregrina.__ Tennessee Warbler. A summer resident of poplar woods, of regular occurrence but in very small numbers. Earliest arrival, May 26, 1934. Latest seen: July 26, 1929; July 25, 1934.

*__Vermivora celata celata.__ Orange-crowned Warbler. Of common occurrence during the southward migration in late summer. In 1924, August 13 to 31; in 1929, August 7 to September 9; in 1931, August 3 to September 9; in 1934, August 25 to September 7.

*__Vermivora celata orestera.__ Rocky Mountain Orange-crowned Warbler. A fairly common summer resident in the lowlands. Dates of arrival: May 24, 1924 (Carcross); May 14, 1930; May 15, 1931;

May 16, 1934. Latest seen: August 28, 1924; August 25, 1934. This subspecies leaves at about the time that the first south-bound *V. c. celata* appears.

***Dendroica aestiva aestiva.** Eastern Yellow Warbler. A common summer resident of the willow thickets in the lowlands. First arrivals: May 15, 1931; May 23, 1934. Latest seen: August 26, 1924; August 24, 1929; August 12, 1931.

***Dendroica coronata.** Myrtle Warbler. Ordinarily an abundant summer resident, mostly in spruce timber; in 1934 almost totally absent during the nesting season. First arrivals: April 27, 1930; April 26, 1931; April 21, 1934; May 3, 1935. Latest seen: October 5, 1931. Adult birds are practically all gone by the end of July.

***Dendroica townsendi.** Townsend Warbler. Rare but of regular occurrence as a summer resident of spruce woods in the lowlands. Migration dates: First arrivals, May 18, 1930; May 22, 1934. Latest seen: August 31, 1924; September 1, 1931; September 1, 1934.

***Dendroica striata.** Black-poll Warbler. A regular summer resident in small numbers. Restricted to the lowlands and partial to the islands in Lake Atlin as a nesting ground. First arrival, May 21, 1934. Latest seen: August 27, 1924; August 19, 1931; August 25, 1934. No adults seen after the end of July.

***Seiurus noveboracensis notabilis.** Grinnell Water-thrush. I have but two records, of a specimen collected by Allan Brooks, August 21, 1924, and of a bird seen by myself June 28, 1929.

***Geothlypis trichas occidentalis.** Western Yellow-throat. Found only as a rare and irregular transient in late summer. Following is the sum total of my records. A number seen September 10, 1924, in a marsh about on the British Columbia-Yukon boundary, some seventy miles northeast of Atlin. One bird collected at Atlin, September 4, 1929. In 1934 one bird was seen about fifteen miles east of Atlin, July 4; two were seen together near Atlin, July 23; and one was collected August 13.

***Wilsonia pusilla pileolata.** Pileolated Warbler. A common summer resident, mostly in willow swamps above the 3,000 foot level. Migration dates: First arrivals, May 17, 1931; May 11, 1934. Latest seen: September 12, 1924 (Teslin); August 24, 1929.

***Setophaga ruticilla.** American Redstart. A summer resident in the lowlands, of rare and irregular occurrence. Seen during June and July, 1924; in 1929 on a few occasions between June 26 and September 3; in 1934, first seen June 7 and only a few times thereafter. None seen in 1931.

*__Agelaius phoeniceus arctolegus.__ Giant Red-wing. Blackbirds, recognized more or less certainly as Red-wings, have been seen by Stewart on various occasions, without a doubt at least twice, August 28, 1931, and June 13, 1932. Finally one was collected by him, a young male taken at Atlin, August 20, 1934. This was a single bird in a flock of Rusty Blackbirds, detected after painstaking binocular inspection of every bird in the flock.

*__Euphagus carolinus.__ Rusty Blackbird. A summer resident in the lowlands, usually in fair abundance but in very small numbers during 1934. Migration dates: Arrivals, April 14, 1931; April 30, 1933; April 25, 1934. Latest seen: October 8, 1931.

There is a definite migration coastward of this species in the early fall, of unknown extent. I saw Rusty Blackbirds in Skagway on September 12, 1934, and was told that they were of regular yearly occurrence there for a short period at about that time. I believe that there must be a return inland before final departure for the south.

*__Molothrus ater artemisiae.__ Nevada Cowbird. I believe that careful observation would detect the presence of a few Cowbirds about Atlin in the late summer almost every year. On August 28, 1931, several were seen by Stewart about some horses in a pasture. Later in the same day another was seen by Stewart and myself together, which was shot but lost. In 1934, one was seen on September 3; an immature male, now in Stewart's collection, was shot by him September 4. The species can be easily overlooked among the abundant Rusty Blackbirds.

*__Carpodacus purpureus purpureus.__ Eastern Purple Finch. I have record of but two occurrences, an adult male collected by myself, June 28, 1924 (what was probably the same bird had been seen at exactly the same place on June 25), and an adult male collected by Stewart, July 25, 1932.

*__Pinicola enucleator alascensis.__ Alaska Pine Grosbeak. A winter visitant, from all accounts of regular occurrence and in fair abundance. Not known to nest anywhere in this general region. Earliest date of arrival, October 23 (1931). When I reached Atlin in 1934, on March 28, the Pine Grosbeaks had already gone.

*__Leucosticte tephrocotis littoralis.__ Hepburn Rosy Finch. A flock of fifteen birds reported as seen on a mountain near Moose River (at the south end of Lake Atlin), September 8, 1913 (Kermode). Aside from this our only definite record for the region is of an adult male collected by Stewart, a single bird in a flock of Snow Buntings, taken March 29, 1933, in the town of Atlin.

***Acanthis hornemanni exilipes.** Hoary Redpoll. Stewart's collection contains two specimens of this species, male and female, collected, respectively, on April 21 and 22, 1931. These were taken from flocks of the Common Redpoll. Careful scrutiny of many additional flocks did not disclose any more examples of the rarer species.

***Acanthis linaria linaria.** Common Redpoll. Irregular in occurrence and numbers. Generally a fairly common migrant in early spring and late fall. In 1924 no Redpolls were seen at any time. In 1929 they were nesting in fair abundance in some localities. Migration dates: Arrivals, April 16, 1930; April 20, 1931; April 20, 1933; April 19, 1934; March 25, 1935. In 1931 migrating Redpolls were present from September 30 to October 15.

***Spinus pinus pinus.** Pine Siskin. Generally a common summer resident. In 1924 the Pine Siskin was seen from June 25 to September 23; in 1934 the first arrival appeared July 20.

***Loxia curvirostra bendirei.** Bendire Crossbill. In 1929 this Red Crossbill was fairly common about Atlin, observed at intervals from June 20 to September 1. All the birds seen were in rather open stands of Jack Pine (*Pinus contorta*) in the lowlands. The species has not otherwise been reported from the Atlin region.

***Loxia leucoptera.** White-winged Crossbill. Known only as an irregular summer visitant, frequenting the forests of White Spruce (*Picea canadensis*). In 1924 it was abundant; first seen June 3. In 1929 it was fairly common, in 1931 less common. In 1934 it was almost totally absent; first seen on July 9 and on only two or three occasions thereafter.

***Passerculus sandwichensis alaudinus.** Western Savannah Sparrow. Abundant summer resident, nesting in swamps and meadows in the valleys, and of general distribution in open country on migration. Migration dates: Arrivals, April 30, 1933; April 19, 1934. Departures: September 21, 1924; September 11, 1929; September 24, 1931.

***Junco hyemalis connectens.** Cassiar Junco. Ordinarily an extremely abundant summer resident in the lowlands. Present in small numbers in 1934. Migration dates: Arrivals, April 20, 1930; April 20, 1931; April 29, 1933; April 22, 1934. Last seen: October 17, 1931. The nesting season is long; I have found sets of fresh eggs as early as May 31, and as late as July 16.

***Spizella arborea ochracea.** Western Tree Sparrow. An abundant summer resident, mostly in willow thickets above the limits of upright timber. Common in the lowlands for short periods upon arrival in the spring and before departure in the fall. Migration dates (in immediate vicinity of Atlin): Arrivals, April 25, 1930; April 26, 1931; April 29 to May 11, 1934. Latest seen: September 15 to October 16, 1931; in 1934 the first south bound migrant appeared at Atlin on August 29.

***Spizella passerina passerina.** Eastern Chipping Sparrow. Common summer resident in the lowlands. Migration dates: Arrival, May 9, 1934. Departures, August 24, 1924; August 26, 1929.

***Spizella taverneri.** Timberline Sparrow. Common summer resident of brushy areas above timberline, mostly from 3,000 to 5,000 feet altitude. Of extremely rare occurrence in the lowlands. The two instances recorded from near Atlin, of specimens collected on May 29, 1934, and September 7, 1931, respectively, supply the earliest and latest dates of occurrence. Specimens were collected on one of the higher summits on September 5, 1929.

***Zonotrichia gambeli.** Gambel Sparrow. Common summer resident in the lowlands; of general distribution in late summer. Migration dates: Arrivals, April 26, 1931; April 30, 1933; April 24, 1934. Last seen: September 5, 1924; September 14, 1929; October 8, 1931. The last date given is probably nearest to the average yearly time of final departure.

***Zonotrichia coronata.** Golden-crowned Sparrow. Common summer resident in brush-covered areas above timberline. A few individuals appear in the lowlands upon first arrival in the spring, and again before final departure in the fall. Migration dates (from the near vicinity of Atlin): Arrivals, May 9, 1930; April 29 to May 12, 1934. Latest seen: September 5, 1924; September 15, 1931.

***Passerella iliaca iliaca.** Eastern Fox Sparrow. A rare migrant and an extremely rare and irregular summer resident. Not seen at all in 1924 and 1929. In 1931 migrants were collected on April 27, May 5, September 14, and September 15. Arrivals were noted on April 26, 1932, May 1, 1933, and May 8, 1934, and in each of these years singing males (three such in 1934) occupied limited areas about Atlin during the summer months. A bird mostly in juvenal plumage was collected July 31, 1934.

***Melospiza lincolni lincolni.** Lincoln Sparrow. An abundant summer resident in the lowlands. Migration dates: Arrivals, April 29, 1931; May 2, 1933; April 25, 1934. Latest seen, August 29, 1924; August 31, 1929; September 18, 1931.

***Melospiza melodia morphna.** Rusty Song Sparrow. An extremely rare summer resident. I saw a single bird at Ben-My-Chree, Tagish Lake, August 27, 1929. Stewart has found Song

Sparrows, probably no more each year than a single pair with their brood, in the same restricted willow thicket at the edge of the town of Atlin; in 1930 (one collected May 16), in 1931 (birds seen by myself July 31 and August 16), and in 1932. We were unable to find them in 1934. First arrival, May 3, 1935.

*__Calcarius lapponicus alascensis.__ Alaska Longspur. A regular and common migrant. Spring: Carcross, May 23, 1924; Atlin, first seen April 25, 1930; May 4 to 18, 1931; April 21 to May 15, 1934; April 11, 1935. Fall: September 1 to 7, 1924; August 29, 1929 (Carcross); September 10 to October 18, 1931; September 17 to November 1, 1932; in 1934, first seen August 29.

*__Plectrophenax nivalis nivalis.__ Eastern Snow Bunting. A regular and fairly common migrant. Dates of departure in late fall and arrival in early spring are probably governed by weather conditions, chiefly by the extent to which the ground is covered with snow. Fall arrivals: October 23, 1931; October 17, 1933. Spring: Last seen, April 17, 1930; April 7, 1933; in 1934, noted from March 28 to April 11. A specimen collected December 7, 1930.

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**No. 3**

# ORIGINS OF THE FAUNA OF THE SITKAN DISTRICT, ALASKA*

BY

HARRY S. SWARTH

*Late Curator, Department of Ornithology and Mammalogy*
*California Academy of Sciences*

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## INTRODUCTION

Islands and mainland of extreme southeastern Alaska comprise a sharply defined geographic area set off by natural boundaries that coincide closely with present day political lines. The region possesses bird and mammal populations, as well as plants, that are sufficiently characteristic to justify the distinctive name "Sitkan district" that has been applied by biologists to this part of Alaska (see Nelson, 1887, p. 24). The natural history of the country has been studied enough and from sufficiently extensive collections to warrant some general conclusions regarding origins of the animal life. My own personal experience includes field work that has covered most of the Sitkan district and some of the coast to the southward, as well as additional seasons spent in the immediately adjoining interior of Yukon Territory and British Columbia. It is,

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I think, the background of actual field experience that is responsible for most of the personal opinions and theories that are here expressed. Conditions east of the Coast Range are touched upon lightly and incidentally in this discussion, but it is surprising to how great an extent field work east of those mountains has supplied clues to the solution of problems concerning the very different fauna west of the range.

In any given region some proportion of the species may be recognized more or less plainly as immigrants from elsewhere, but there are not many places sharply circumscribed as is the Sitkan district where the facts regarding immediate origins are so plainly indicated in such a large number of cases, and where so many rather striking deductions and inferences follow even limited comprehension of observed facts. Not that the whole story is presented here by any means, even of the representative species to which this discussion is confined. There is much that remains obscure in the local distribution of forms. Each species has its own history, with details varying from those of all the others, though in general agreement with some one of the several categories of immigrants that may be recognized. Then, while our knowledge of species and conditions is reasonably satisfactory, there is no doubt that further field work in the region would add much, especially in information about the small mammals. Furthermore, the mainland coast of British Columbia is practically unexplored as regards its fauna, and while this is of lesser concern so far as birds are concerned, it is of extreme importance with the mammals. The stretch of coast line extending southward from the Alaska boundary unquestionably holds valuable information bearing upon the Alaskan species.

## Physiographical features of the Sitkan district

The Sitkan district, Alaska, as here defined, includes the Alaska "pan-handle," namely, a narrow strip of mainland coast west from the summit of the Coast Range, from Glacier Bay at the north, south to Dixon Entrance, together with the adjacent islands, the Alexander Archipelago. The region described has been more recently glaciated than any other section of North America. "The great cordilleran ice sheet of northwestern America, which, according to Dawson, swept north and south from its source in British Columbia, probably only reached into southeastern Alaska, where it passed through the coast range gaps, and, uniting with the local glaciers from these mountains, helped to scour out the extensive system of waterways of the Pacific shore and covered a good part of the Alexander Archipelago. The evidence of glacial erosion in this southeastern province indicates a great thickness of ice, and here, unlike other parts of Alaska, the ice overrode considerable altitudes. The large unmapped areas in the islands make it impossible to indicate the limits of the ice sheet, but it probably covered most of the archipelago[1] and dumped its debris directly into the Pacific beyond" (Brooks, 1906, p. 246). Dawson (1888, p. 347) also says "The glacier extending from the mainland coast touched the northern shores of the Queen Charlotte Islands"; and (*op. cit.*, p. 348) "The front of the glacier must have passed the outer border of the Archipelago, as at Sitka well-marked glaciation is found pointing toward the open Pacific." (See also F. E. and C. W. Wright, 1908, pp. 27, 77.) It should be borne in mind, too, that "The glaciation of Alaska is to be regarded rather as an extension of the present system of alpine and piedmont glaciers than as a continental ice sheet. . . . The older glacial system was, however, far more extensive, and in southeastern Alaska approached the continental type" (Brooks, 1906, p. 245).

In general, the Pleistocene is regarded as including the last epoch of extensive glaciation, but, clearly, much of southeastern Alaska must have remained ice covered after the close of that period. This region now contains the most extensive glaciers in North America, glaciers that have changed enough during the few years that they have been under observation to suggest enormously greater expanse even a few hundred years ago. Publications on this subject written by various individuals convey more than an implication of this belief (see Wright, 1887, pp. 250-256). The one dissenting account that I have seen (Capps, 1915) deals with the White River Basin, Wrangell Mountains, about at the northern limit of glaciation in this part of Alaska, and it is not clear that the author's conclusions regarding conditions at this inland station are applicable to the coast. He places the period of glacial retreat at that point as far back as 8,000 years.

From the foregoing discussion it would seem that the post-glacial reoccupation of southeastern Alaska by animal and plant life must have been at a more recent date than was the case in any other as extensive area in temperate North America. The inescapable and important conclusion is that whatever is peculiar to the Sitkan fauna and flora must inevitably have developed subsequent to Pleistocene time. Avian paleontologists have lately been expressing more and more definitely their conviction that many present day forms are of greater age than this, that modern genera were in existence in large part in the Miocene, some of them still earlier. "In the Miocene. . . . appear birds so closely allied to our modern species that in many cases they may be assigned to living genera." "When the avifauna of the Ice Age and of the latter part of the Tertiary is better known we shall unquestionably find it much richer in species than is the case in present times since the greater part, if not all of our modern forms, were in existence contemporaneously with many peculiar birds that have become extinct" (Wetmore, 1927, pp. 182, 183). Paleontological evidence deals with structural characters, necessarily. In the Sitkan fauna we seem to be supplied with evidence

[1] Not, however, the highest summits. H. S. S.

bearing upon the age of such external characters as color and pattern. Here we have a number of strongly characterized forms (mostly "subspecies," though there are some that we call species) that show a common tendency to vary in the same direction, and that have developed subsequent to the Pleistocene. It seems, therefore, that in the Sitkan district, Alaska, considered in contrast with adjacent regions, the present day fauna and flora afford excellent subject matter for speculation upon species formation. There are not many regions where we can assume, as here, so nearly exact and so recent a date for the inception of its animal life. From the adjacent interior of Alaska and Yukon there is abundant representation of fossil animals of Pleistocene time (see Gilmore, 1908; Quackenbush, 1909); it seems a fair assumption that conditions favorable for animal and plant life prevailed inland a little farther north when the whole coastal region was still buried under glacial ice.

The Sitkan district is characterized by heavy rainfall and relatively mild temperatures. It includes some of the wettest parts of the northwestern rain belt, with annual average precipitation of from 75 to 200 inches, perhaps more. "The temperature throughout southeastern Alaska is remarkably equable. The extremes recorded at Sitka show for August, the hottest month, an extreme range of from 35° to 87° F., and for the coldest month, February, a range of from 3° to 54° F. The mean temperature for January is 33°, and for August 56°, a range of only 23°" (Brooks and Abbe, 1906, p. 144). Mainland stations have more severe winter weather, with the mean annual temperature several degrees lower, and the inland fiords are decidedly colder than the outer coast line.

This is a region of dense vegetation, though with a limited variety of trees. Dense forest grows everywhere from the high-tide line upward to timber line. The dominant trees are the Sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*), and there are lesser proportions of mountain hemlock (*Tsuga mertensiana*), western red cedar (*Thuja plicata*) and yellow cedar (*Chamaecyparis nootkatensis*). A few jack pine (*Pinus contorta*), small and twisted, grow in the bogs. Along the beaches, bordering the forest, there is nearly everywhere a line of alders (*Alnus sinuata*), and in places extensive thickets of willow, salmon-berry and devil's-club. There are small areas of grass-land where occasional high tides reach, and some open country (often snow or ice covered) on the higher summits of the islands.

The mainland strip of the Sitkan district is extremely narrow, the slopes of the Coast Range rising abruptly from the water's edge. The adjacent Alexander Archipelago comprises a multitude of islands with an intricate system of intervening channels. These waterways, some that are miles in width, others only a few yards across, are mostly protected from the swell of the open sea, but they are traversed by prodigious tides, in some places rising and falling twenty or thirty feet.

So, to summarize, the Sitkan district is a region of equable and rather cool temperature, of cloudy skies and heavy rainfall; densely covered with well-nigh impenetrable forest; a mass of mountainous islands mostly, separated by tide-swept channels; and offering a decidedly limited variety of surroundings to any potential fauna.

East of the separating Coast Range, less than one hundred miles inland, lies the interior of British Columbia, the western border of subarctic Canada, presenting sharp contrast to the coast in many respects, markedly so in the animal and plant life. This is a country of broad valleys, of lesser and scattered mountains and hills, of magnificent lakes and broad rivers. The valley floor at Atlin is at about 2,200 feet altitude, at Telegraph Creek 540 feet, and at Hazelton about 1,000 feet. There is here an abrupt falling off in amount of rainfall, Carcross, Atlin and Telegraph Creek having each an annual precipitation of from twelve to fifteen inches. At Hazelton, in the upper Skeena Valley, it is considerably more. Winters are severely cold, summers much warmer than on the coast. The inland woods, mostly rather open, are of different species from the coastal forests. The quaking aspen (*Populus tremuloides*) covers much of the lowlands, with balm of Gilead and birch in lesser abundance. White spruce (*Picea canadensis*) in the north, Engelmann spruce (*P. engelmanni*) farther south, are dominant lowland conifers, while alpine balsam (*Abies lasiocarpa*) grows on the heights, in prostrate form at its upper limit.

Between the Canadian interior and the Alaskan coast is interposed the formidable barrier of the Coast Range, a mountain chain about 60 or 70 miles through, both slopes rising abruptly, in places to 8,000 or 9,000 feet above the sea. These mountains are a barrier of absolute effectiveness as regards most animal species, in the climatic conditions induced on either side, in their rugged character and in the enormous areas that are still glacier-covered; and in the fact that the few openings through the range are densely covered with forest that is unattractive and inhospitable to nearly all birds and mammals. In the valley of the lower Stikine, one of the most important of the passes, there is heavy winter snowfall that is very slow to melt. The advent of spring is weeks later there than in the country on either side of the mountains, and this is an important factor in the delimitation of bird species which have to make the most of a brief summer.

There are a few channels of communication between the coast and the interior, offering varying degrees of accessibility. There are at the northern end of the Sitkan district the passes leading down to the head of Lynn Canal. About one hundred miles to the southward, near Juneau, is the valley of the Taku River, and one hundred and fifty miles farther, the valley of the Stikine, both important channels through the Coast Range. One hundred and fifty miles farther, at the southern boundary of Alaska, is Portland Canal, extending far inland, and just beyond, the Skeena River. This river flows through a broad valley, piercing the Coast Range at a point where the mountains are of lesser height than farther north, thus permitting a more free intermingling of coastal and interior elements than elsewhere. Coastal rains and fog drift farther inland, and are accompanied by coastal species to some extent, and, on the other hand, certain influences from the interior have markedly affected the coastal fauna.

Compared with the coastal strip to the southward, the Sitkan region is of appreciably colder temperatures and of greater humidity, the variation in both respects southward into California being of gradual accomplishment. Compared with the adjacent interior east of the Coast Range, the Sitkan region is of a more equable climate with much milder winters, and it is of enormously greater humidity, these changes being accomplished most abruptly, within a distance of forty or fifty miles.

Along the entire coast, from Lynn Canal to Puget Sound, close restriction of the powerful coastal influences at the east is an important factor, of course, in the distribution of animal life; and it must be borne in mind as of no less importance in a discussion of possible routes to be followed by immigrant species from other parts. North-bound invaders that were sensitively adapted to coastal conditions have had an extremely narrow margin along which to travel. A slight mechanical obstacle on the coast became impassable when flanked by adverse climatic conditions so short a distance inland.

The retreating glaciers still linger on the mainland mountains of southeastern Alaska, where even now they cover hundreds of square miles. Disintegration travelled from west to east; clearly the islands were first to be free of the ice covering. On the whole Pacific coast from Puget Sound northward there is a bordering fringe of islands. First is Vancouver Island, slightly separated from the mainland, then along the British Columbia coast a narrow line of small islands lying close along the coast and the Queen Charlotte Islands farther out. From Dixon Entrance northward the Alexander Archipelago abruptly attains a width of one hundred miles or more, but with no very broad separating channels. That group of islands and perhaps some of those to the southward, together with the more remote Queen Charlotte Islands, must have been cleared of most of their glacial covering when the adjacent mainland still presented a wall of ice along its entire shore line. Birds with their powers of flight could advance quickly and freely northward from island to island; terrestrial mammals were shut off to the southward for a much longer period, until the slowly retreating glaciers began to leave a passage, narrow and interrupted to this day, along the mainland coast. So that the colonization of the Sitkan district by bird species from the southward, to the exclusion of most mammals, is perfectly comprehensible. The region, too, must for a long time later have been so completely isolated from any eastern approach that the absence of birds from that direction can also be understood.

In a later period channels of communication above described were opened between coast and interior, north and east, through which various mammals passed, to compose the scanty mammal fauna that slowly and painfully progressed over varying parts of the Alexander Archipelago. The sifting through of these relatively few species must have been a long slow process. At a much later time an occasional bird species followed. This sort of colonization of both birds and mammals seems to me to be discernibly proceeding at the present time. As to the mechanics that controlled the actual planting of mammal species here and there, the imagination that would reconstruct past events will find stimulus in the vast surviving Alaskan ice fields, spanning the Coast Range as they do, and with raw traces of former activities spread out before their retreating fronts. At that, however, it might well be that actual sight of the continental ice sheets of Greenland or Antarctica is required to enable one to form a mental picture of what may have taken place in the northwest. This vision would paint a bleak unending ice field bordering salt water, broken only by small nunataks near the sea, by larger masses of rock, the Coast Range summits, farther back, an icy world that remained unchanged for ages. At last there transpired the gradual emergence of a rocky western coast line, of western islands, of channels that are sometimes distinguishable as such but still for ages longer clogged or hidden by bergs and other glacial debris swept down from mainland centers. Favored mainland sections, ice-free at last and eventually reached by mammalian life, could then have contributed a representation of species small enough to be borne to the islands upon such flotsam as the bergs might carry, or as today is brought down the large rivers and tossed upon island shores. Aquatic and semi-aquatic species would find opportunities for dispersal or have such thrust upon them. It would be a long slow process, slower than one can well realize, of the chance extension of a species from one island to the next, of the successive colonization of nunataks not yet recognizable as islands, all modified by glacial advances and recessions, and in the midst of tossing ice fields that must have been hurled in solid masses up and down the tide-swept channels long after the period when the glaciers, as such, ceased to fill these submerged valleys.

Along the mainland coast as far south as Puget Sound the retreating ice-front would release segments of coast, each bounded north and south by deep fiords or valleys still filled with ice. With the separated glaciers dwindled or vanished at the heads of these long valleys, paths were opened toward the coast for the westward advance of scattered inland colonies of various species of animals. These same narrow valleys, however, flooded with salt water sometimes twenty-five or thirty miles back from the general coast line, and extending inland to the limit of coastal influences or beyond, although acting as highways from the east, formed a series of interruptions to the northward advance of any southern mammal that clung at all closely to the coast.

## BIRDS

The birds of the Sitkan district form an assemblage that is separate and sharply distinct from that of the adjacent interior. There are very few species or subspecies that occur commonly in both sections. Birds and mammals of the Sitkan district have been regarded as possessing in common an extreme of dark brownish coloration, which is true to a certain extent but is not universal. This conception regarding the birds arose from the appearance of a group of fourteen or fifteen subspecies, the local representation of certain wide-spread and variable species, which occur in some abundance. Conspicuous among them are:

Great Blue Heron (*Ardea herodias fannini*)
Canada Goose (*Branta canadensis occidentalis*)
Sooty Grouse (*Dendragapus fuliginosus sitkensis* and *Dendragapus fuliginosus fuliginosus*)
Great Horned Owl (*Bubo virginianus saturatus*)
Red-shafted Flicker (*Colaptes cafer cafer*)
Steller's Jay (*Cyanocitta stelleri stelleri*)
Oregon Junco (*Junco oreganus oreganus*)
Song Sparrow (*Melospiza melodia rufina* and *Melospiza melodia morphna*)
Fox Sparrow (*Passerella iliaca townsendi* and *Passerella iliaca fuliginosa*)
Chestnut-backed Chickadee (*Penthestes rufescens rufescens*)
Ruby-crowned Kinglet (*Regulus calendula grinnelli*)

There are additional species in which the "saturated" coloration is not so noticeable. They, with the previous list, all possess one common characteristic: residence the year through within the rain belt. Either they are permanently resident in the northern humid coast or else they perform a limited southward migration, perhaps as far as California, a migration that does not extend beyond the belt of heavy winter rainfall. Only resident forms have responded to local influences.

Here is a supplementary list representative of another set of breeding birds of the Sitkan district:

Western Flycatcher (*Empidonax difficilis difficilis*)
Lutescent Warbler (*Vermivora celata lutescens*)
Townsend's Warbler (*Dendroica townsendi*)
Pileolated Warbler (*Wilsonia pusilla pileolata*)
Russet-backed Thrush (*Hylocichla ustulata ustulata*)

These, in contrast to the first lot, perform distant migrations, mostly into Mexico and beyond, and, breeding from southern California to Alaska, they remain essentially unchanged throughout this habitat. They have not been affected by the stimulus that has darkened the resident species.

A third list:

Mallard (*Anas platyrhynchos*)
Spotted Sandpiper (*Actitis macularia*)
Greater Yellow-legs (*Totanus melanoleucus*)
Sharp-shinned Hawk (*Accipiter velox*)
Pine Siskin (*Spinus pinus pinus*)
Barn Swallow (*Hirundo erythrogaster*)
Tree Swallow (*Iridoprocne bicolor*)
Dipper (*Cinclus mexicanus unicolor*)
Western Golden-crowned Kinglet (*Regulus satrapa olivaceus*)

This is a selection of birds, wide-spread across North America or in the western half, some of them extensively migratory, two, at least (Dipper and Mallard), permanently resident, but all rather resistant, non-variable species, and none of them showing response in color to the influence of the humid coast.

Fair comparison can be made between the Canada Goose and Mallard, between Great Blue Heron and Spotted Sandpiper, between Song Sparrow and Pine Siskin. The Goose, Heron and Song Sparrow produce local races in other parts of their respective habitats, as in the Sitkan district; Mallard, Spotted Sandpiper and Pine Siskin are elsewhere indifferent to varied climatic surroundings, and have not altered perceptibly in the coastal environment. It is only notably plastic forms that have had time to respond to local influences.

Thus the strongly marked subspecies that are accepted as characteristic of the Sitkan district are, firstly, resident therein or within the slightly broader limits of the humid coast belt; and, secondly, they are races only of species whose external appearance varies so in different parts of their ranges as to suggest that slight influences and relatively short time are required to bring about such changes.

The Sitkan avifauna is composed mostly of species that are of southern derivation, northern offshoots of birds that are rather exclusively western or belonging to the still more limited Pacific slope. Among the few northern birds of permanent establishment and in fair abundance are the Willow Ptarmigan (*Lagopus lagopus alexandrae*) and Rock Ptarmigan (*Lagopus rupestris dixoni*), the former at high altitudes on all the larger islands, the latter on the more northern ones. The Pine Grosbeak, too, belongs in the category of northern immigrants. Clearly, though, it was the bird species from the south —and west of the southern Coast Ranges—that had first access to the region, pushing northward as conditions permitted, always west of the mountains.

In the Sooty Grouse, in the Fox Sparrows, and in the Song Sparrows there are well-defined subspecies occupying western and eastern portions of the Sitkan region. In the Grouse and Fox Sparrows one form occupies the Alexander Archipelago and the Queen Charlotte Islands, another the mainland coast. In the Song Sparrow one form occupies the westernmost islands of the Archipelago and the Queen Charlotte Islands, another the inner islands and the mainland coast. This carries the suggestion that as the westernmost part of the region became free of ice, the first section to be habitable, it was at once occupied by these species; and these western colonies now show their greater age in their differentiation from the mainland stock.

At a much later period there began to be an occasional invader from the east, struggling through the few difficult passes from the interior, a movement that can be discerned today at such places as the mouths of the Skeena, Stikine and Taku rivers. At such spots there have been found small colonies or single birds of the following inland forms (see Swarth, 1911):

Olive-sided Flycatcher (*Nuttallornis borealis*)
Western Wood Pewee (*Myiochanes richardsonii richardsonii*)
Alder Flycatcher (*Empidonax traillii traillii*)
Louisiana Tanager (*Piranga ludoviciana*)
Cedar Waxwing (*Bombycilla cedrorum*)
Western Yellow-throat (*Geothlypis trichas occidentalis*)
Tolmie Warbler (*Oporornis tolmiei*)

These are species that have barely secured a foothold on the coast, but some of them, at least, do breed there in small numbers without reaching the islands beyond. At some distant period the Hairy Woodpecker (*Dryobates villosus*) arrived through these channels and occupied the whole region, long enough ago to have since developed as a distinguishable subspecies, *D. v. sitkensis*. This form seems clearly to be an offshoot of the same white-breasted inland strain as *D. v. septentrionalis* of the Yukon region, and *D. v. monticola* of interior British Columbia, and not of the dark-breasted strain (*D. v. harrisi*) of the southern coast of British Columbia, as was formerly assumed. The Downy Woodpecker (*Dryobates pubescens leucurus*) and the Three-toed Woodpecker (*Picoides tridactylus fasciatus*) also reach the coast as migrants or occasional visitants, but have hardly established residence there. Another inland bird, Franklin's Grouse (*Canachites franklini*), unchanged, occupies some of the southern islands.

It is the species of southern derivation that have developed the striking local subspecies. The more recent arrivals from the east, even the sedentary Franklin's Grouse, have mostly not changed; the Hairy Woodpecker is one that has altered perceptibly. Of Sitkan subspecies that can be regarded as invaders from the north, such as Alexander's Willow Ptarmigan, Kodiak Pine Grosbeak, and Hepburn's Rosy Finch, all occupy additional territory too far to the northwest for these races to be considered as local products of the Sitkan district.

The broad valley of the Skeena forms a medium of communication between interior and coast that has had marked local results. Some species, such as the coastal Song Sparrow and Red-breasted Sapsucker, press far inland, meeting with no closely related form. The Yellow-shafted Flicker of the interior and the Red-shafted Flicker of the coast meet, with the result that the entire Flicker population 200 miles inland is strongly tinged with characteristics of the coastal species; hybrids also occur in the red-shafted population of the Alaska coast near the mouth of the Skeena. Franklin's Grouse must have reached the southern Alaskan islands through the avenue provided along the Skeena.

Local variation in Steller's Jay (*Cyanocitta stelleri*) hereabout leads to certain deductions that are at least worth stating. This species appears to be of far southern origin, extending from the highlands of Central America northward. There are two divergent strains, one in the Rocky Mountain region characterized by white markings on the eyelids, the other on the Pacific slope lacking these markings. At the southern limit of the last mentioned the two strains are separated by some hundreds of miles occupied by neither form, and there is no intergrading there. At the north, in the lower Skeena, the two strains are joined, and birds with the head markings of the interior Black-headed Jay (*Cyanocitta stelleri annectens*) occur upon the coast in the ascribed range of Steller's Jay (*C. s. stelleri*). There is apparently true intergradation here between the two subspecies, such as I believe does not exist elsewhere between these two strains. Along the coast north of the Skeena and south of the Skeena "typical" *stelleri* occurs. Opposite the mouth of the Skeena, on the Queen Charlotte Islands, is the still more heavily "saturated" subspecies, *C. s. carlottae*. The point to be emphasized is that where *stelleri* and *annectens* meet intergradation, that is, merging of characters, actually occurs. The significance of this fact becomes apparent when we consider that in the case of almost every other variable species in this region with separate inland and coastal subspecies, wherever they meet—and many of them do meet—they come together as distinct species, either not interbreeding at all or else producing occasional hybrids. I have come to the belief that these meetings are between strains that have long been separated, extending northward along separated routes and eventually coming together at too late a period to permit intermixture; though, perhaps, in the far south the representatives of the same two strains might never have broken entirely apart. By this theory the two strains of *Cyanocitta stelleri* did not meet in this northern region—on the contrary, this was the point of separation. It looks to me as though the Jays of this species (*Cyanocitta stelleri*) might have emigrated northward and westward along the Rockies, reached their present northwestern limit in the Skeena drainage, arrived thereby to the coast, and from this base or thereabout, spread northward and southward over their present-day habitat on the Pacific slope.

There are bird species of circumpolar distribution with widespread representation in the New World as in the Old, that in both regions moved from the north southward to occupy their present habitats. Of this category the Willow and Rock ptarmigans were apparently early and direct immigrants into the Sitkan district, but with these exceptions and one or two others the southbound northerners were deflected to the eastward, away from the coast. The American Three-toed Woodpecker is one that at a later period made an indirect approach from the eastward when opportunity offered, exemplifying a colonization scheme that is still in its early stages. Magpie, Bohemian Waxwing, Common Redpoll and Northern Shrike are all species that were barred from the coast in the southern expansion of their habitats and are now found east of the Coast Range in association with southern species that were similarly barred in their northward migrations. The Pine Grosbeak of the Sitkan district is apparently the same subspecies (*Pinicola enucleator flammula*) as that of the Alaskan coast to the northwest, as far as Kodiak Island. From its extreme rarity it may be supposed to be a recent arrival from the northern part of its range; but in any event it is one of the very few coastal species that has penetrated eastward through the Coast Range. The coastal Pine Grosbeak occurs inland along the Stikine River as far as Telegraph Creek. Hepburn's Rosy Finch is another bird of northern derivation, and the Rusty Song Sparrow and Sooty Fox Sparrow are birds of southern origin, that have likewise extended their habitats inland as far as the eastern face of the Coast Range along the same river valley. These birds have all entered a region that is not otherwise occupied by the several genera to which they belong.

There are about twenty kinds of birds with complementary representation on the coast and inland, as subspecies or closely related species; in most cases there is no more intergradation exhibited between the subspecies than between the species. Exceptions are found in the subspecies of the Hairy Woodpecker, Steller's Jay, Lincoln's Sparrow and Yellow Warbler. As regards the Hairy Woodpecker and Steller's Jay, my conviction, as already explained, is that the coastal populations are directly derived from the interior stocks and that there has never been separation. The same is probably true of the coastal subspecies of Lincoln's Sparrow (Forbush's Sparrow) and of the Yellow Warbler (the Alaska Yellow Warbler). In both cases mode of occurrence upon the coast favors this view, and both are very faintly distinguished local forms, even in their extreme manifestations.

For the rest, the long list of species with comparable representation on the coast and inland includes such contrasting forms as Sooty Grouse and Richardson's Grouse, Western Red-tail and Harlan's Hawk, Red-shafted Flicker and Yellow-shafted Flicker, Oregon Junco and Slate-colored Junco, Chestnut-backed Chickadee and Hudsonian Chickadee, Russet-backed Thrush and Olive-backed

Thrush. In none of these cases are there found between contrasting forms any intergradient populations; the differences are all clean cut.

There is a long list of bird species of the interior that have no comparable representation on the coast. The list of Sitkan birds that have no representation east of the Coast Range includes characteristic coastal subspecies, common birds in the region mostly, of the following species: Canada Goose, Pine Grosbeak, Rosy Finch, Song Sparrow, Fox Sparrow, Winter Wren, Brown Creeper, Golden-crowned Kinglet, and Varied Thrush. These are all widely distributed species that occur north and south of this region. In some cases outlying colonies of one or another of these birds have advanced a short distance inland, but there is an enormous extent of northern British Columbia immediately east of the Coast Range that has none of these species represented in a breeding population.

## Mammals

Of the mammals of the Sitkan district, those that clearly are directly derived from the north are found on the three large islands, Chichagof, Baranof and Admiralty, the northernmost of the archipelago and most easily accessible from the northern mainland. These species include the huge brown bears, at their southern limit upon these islands, and the Sitkan Meadow-mouse (*Microtus sitkensis*).

As regards the rest of the islands and the mainland, most of the smaller species arrived from the adjacent interior east of the Coast Range, their origin and their recent arrival being clearly shown in a great many cases by the mode of variation and by the local distribution of the species concerned. That the islands of the Alexander Archipelago were thus populated after their separation by the present network of channels may be inferred from the steady diminution in the numbers of species as one progresses westward from the mainland, island by island. At various mainland localities between Juneau and Dixon Entrance as many as twenty-four species of mammals may be expected to occur. Of certain large islands immediately adjoining the coast, there are thirteen species recorded from Admiralty, twelve from Kupreanof, and twelve from Revillagigedo. Going farther west, there are six from Coronation, five from Warren, and seven from Dall.

To take specific examples, the following species occur along the mainland coast but on none of the islands: Mountain Goat (*Oreamnos*), Stikine Jumping Mouse (*Zapus saltator*), a Red-backed Mouse (*Clethrionomys phaeus*), and a Marmot (*Marmota caligata*). Other common mainland forms reach one or two of the most accessible islands: Porcupine (*Erethizon dorsatum*) on Wrangell and Etolin; a Jumping Mouse (*Zapus hudsonius*) on Revillagigedo; Musk-rat

(*Ondatra zibethica spatulata*) on Revillagigedo and Sergief; a Red-backed Mouse (*Clethrionomys wrangeli*) on Revillagigedo and Wrangell; a Lemming Mouse (*Synaptomys dalli wrangeli*) on Wrangell; a Flying Squirrel (*Glaucomys sabrinus zaphaeus*) on Etolin, Wrangell and Prince of Wales.

The distribution of the Sitkan Red Squirrel (*Sciurus hudsonicus picatus*) seems to be plainly the result of the accessibility of certain islands from the mainland under present conditions. This squirrel occurs on all the inner line of southern islands that are so slightly separated from the coast, and it is also on certain islands (Mitkof, Kupreanof and Kuiu) that, extending to the western limits of the archipelago, form a series of easily traversed stepping stones from the coast. Osgood (1900, p. 28), in his description of the White Pass Red Squirrel, *Sciurus hudsonicus petulans*, remarks: "The closest relationship of this red squirrel is evidently with *hudsonicus* of northern Alaska. . . . There is ample material demonstrating by skulls as well as by color that it has no very close relationship to *S. vancouverensis*" (of Vancouver Island). *Petulans* is clearly an intermediate step between inland *hudsonicus* and Sitkan *picatus*.

The Timber Wolf is found upon the same islands as the Red Squirrel, and also upon the large Prince of Wales and Dall islands with some others of this southern group that the squirrel has never reached. Evidently the wolf did not come directly from the north. Island distribution of Timber Wolf and Black Bear is exactly the same. If the significance here is that these islands were equally accessible to both species, then the complementary distribution of Black Bear and Brown Bear in the archipelago, nowhere found both upon the same island, is no more than a coincidence.

The Meadow-mice excellently illustrate island distribution as determined by recent accessibility. (See map, fig. 1.) The Sitkan Meadow-mouse (*Microtus sitkensis*) is only on Chichagof and Baranof, and it is the only *Microtus* upon those islands. This is a southern offshoot of a group of mice (the *operarius* group) that occupies much of the Alaskan mainland to the northward. The islands where it is found are conceivably accessible from the northern mainland, surrounded by the open sea and mighty channels on other sides. The most common Meadow-mouse of the Sitkan district is *Microtus mordax littoralis;* this is a local race of *M. mordax*, which is of common and wide-spread occurrence east of the Coast Range. *Littoralis* has been found at some points on the mainland coast, and it occupies most of the islands, but not Chichagof and Baranof. The ancestral *mordax* may be assumed to have reached the coast from the adjacent interior at a very early period. It has been there long enough not only to have developed a recognizable local race of wide-spread distribution over the archipelago, but to have produced also the remarkable giant form, *Microtus coronarius*, that occupies certain of the small out-lying islands.

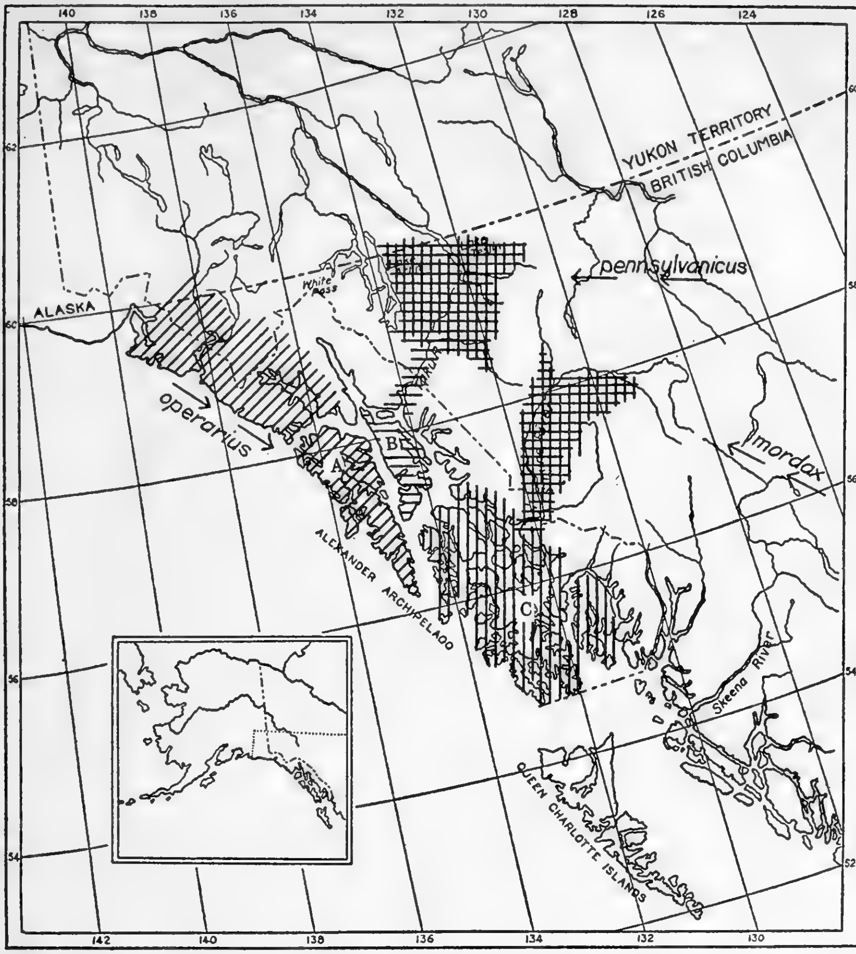


Fig. 1. Map showing distribution of *Microtus operarius* (A), *M. pennsylvanicus* (B), and *M. mordax* (C) in southeastern Alaska. Arrows indicate assumed lines of migration of the species. *Pennsylvanicus* and *mordax* occupy in company most of the adjacent interior of British Columbia, *operarius* most of Alaska; the map shows only such limited portions of the general ranges as contributed directly to colonization of the coast. Map drawn by Miss Margaret W. Wythe.

Drummond's Meadow-mouse (*Microtus pennsylvanicus drummondi*), abundant throughout the northwestern interior, has found its way through the Coast Range in at least two places, along the valleys of the Taku and Stikine rivers. Presumably it is of more recent arrival upon the coast than the predominant *littoralis*, for although there are colonies at the mouths of those streams the species has not spread farther on the mainland. It is noteworthy, however, that it did reach Admiralty Island, the northern end of which is directly opposite, and not very far removed from, the mouth of the

Taku. The island mouse has been given a name, *admiraltiae*, but it is very slightly different from the mainland *drummondi*.

There are two species of shrew that occur in abundance in the Sitkan district, the Masked Shrew (*Sorex cinereus*) and the Dusky Shrew (*Sorex obscurus*), each represented by local subspecies. The species *Sorex cinereus* is transcontinental in range, extending across northern North America. The species *Sorex obscurus* is western, found from the Rocky Mountains to the Pacific. I receive the impression that *obscurus* was the first arrival in the northwest, probably coming from the south. It is of more general distribution than the other, having reached even the westernmost of the islands of the Alexander Archipelago and also the Queen Charlotte Islands. *Cinereus* occurs on the large northern islands, Baranof, Chichagof and Admiralty, but in the south it has not got beyond the islands that immediately adjoin the mainland. Delimitation southward at Frederick Sound, westward at Clarence Strait, is suggestive of invasion from north and east. The coastal population of *Sorex cinereus* is comprised in just one subspecies, *S. c. streatori*, and that one is but slightly differentiated from the inland parent stock. The Dusky Shrew (*Sorex obscurus*), besides attaining to every island, has been long enough resident to have evolved four recognizable subspecies, *S. o. alascensis* in the region about Juneau, *S. o. longicauda* on the mainland coast farther south, *S. o. elassodon* on most of the Alexander Archipelago and on the Queen Charlotte Islands, and *S. o. malitiosus* on the small islands, Coronation and Warren.

There are on the Alaskan coast small colonies of certain mammals, such as Marmot, Porcupine and Muskrat, that do not occur on the coast farther south. These obviously are derived from inland sources, and their presence affords evidence corroborative of the impression that many other components of the Sitkan mammal fauna came from the same direction. The one Sitkan mammal unmistakably of southern coastal origin is the Black-tailed Deer (*Odocoileus columbianus*). This is the only ungulate upon the islands, in contrast to conditions in the adjacent interior, where Moose, Caribou, Mountain Goat and Mountain Sheep abound. Rare upon the mainland, this deer is extremely abundant on all the Alaskan islands, where it reaches the northernmost point attained by the genus *Odocoileus*. It is equally abundant upon Vancouver Island, but the species never reached the Queen Charlotte Islands. The Dusky Shrew, previously mentioned, is the only other mammal of which there seems a fair likelihood of arrival from the south along the coast.

Among the mammals, as with the birds, there are well-defined forms that are restricted to the western islands, affording corroborative evidence of an earlier fauna existent in that part. The peculiar distribution of *Peromyscus sitkensis* and *Microtus coronarius* is certainly suggestive of these being representatives of a relict fauna.

In studying the origins of a given fauna some light may be obtained through considering species that might be expected to occur within the area but do not. In the present case there are excellent examples at hand. There are no rabbits in the humid northwest coast region —a remarkable fact. There are rabbits over most of the world, in as widely diversified surroundings as any form of animal life, and the rabbit meets these varied conditions with a minimum of structural change. Under the circumstances, the absence of these animals from the coastal forests would seem to be due to there not having been time since establishment of those forests for invaders from the abundant rabbit population of the adjacent interior to have acquired any slight adaptations necessary for existence on the coast; in other words, that the coastal area has been habitable for a relatively brief period.

There are no native cats in the northwest coast region. The Canada Lynx is of general distribution across subarctic North America eastward from the Coast Ranges. In the periods when the fluctuating rabbit population is at its height the Lynx, too, increases in numbers, and at such times occasional individuals wander to the coast, but otherwise the species is absent from the rain-belt. That the Lynx has failed to establish itself in the Sitkan district, despite sporadic visitations that prove the animal's ability to reach the place, might be ascribed to the absence of rabbits from that section, and of other suitable prey in sufficient quantity, but these apparent deficiencies do not supply a satisfactory explanation. It is a notable fact that the Puma has similarly failed to invade the Sitkan district from the south, under apparently favorable conditions. Deer, the usual prey of the Puma, extended their habitat northward and over the Sitkan islands as climatic conditions permitted, but the Puma, abundant on Vancouver Island, encountered some adverse influence north of that point that did not affect the Black-tailed Deer. This could not have been excessive rainfall alone, for there is not sufficient difference in this regard between the west coast of Vancouver Island and the Sitkan district. If the explanation lies in the difference in temperature, it bespeaks a notable lack of adaptability, that, in the period when the Deer was pressing northward, the Puma could not become accustomed to the relatively slight drop in temperature, even when supplied with an abundance of its accustomed food and under conditions where this food was singularly easy to secure. There is the suggestion here, in harmony with the general aspect of the Sitkan fauna, that the Alexander Archipelago acquired its deer population after the islands became water-girt, the intervening channels—no obstacle at all to deer—being barriers of absolute efficiency against Puma and Lynx. At any rate, the Sitkan district of Alaska and the British Columbia coast for a long distance south of Alaska, are uninhabited by any species of native cat. This is a deficiency to be pondered by those who believe that in the last analysis the numbers of any species of animal are governed by the available supply of food.

There are other species, too, such as Muskrat, Porcupine and Red Fox, to name some of the most notable, whose slight establishment upon the Alaskan coast or entire absence therefrom seem best explained as due to the very recent accessibility of the region to those animals. Viewing the wide-spread and diversified habitats some of them already occupy, it is hard to believe in the presence of factors in the Sitkan surroundings that are sufficiently adverse to prohibit existence there. The scanty colonies here and there of one species or another are strongly suggestive of a slow advance, each along some favorable path, the several species being thrust forward to varying degrees in the partly occupied territory. Coast and interior are widely different in details of the plant assemblages, with different trees and different shrubs, but certain types of surroundings are closely duplicated in the two sections. There are forests, bogs, and open, timberless mountain tops among the various "habitats" of the two regions; and scanning the distribution of certain of the animals in question it is evident that acceptability of surroundings (the "ecological niche") is not necessarily determined elsewhere by the specific identity of the assembled plants. It is hard to believe that the Porcupine can thrive in white spruce forests but not in Sitka spruce. It is hard to believe that the presence of Franklin's Grouse in a restricted portion of the Sitkan district is due to anything but the accidental and recent accessibility of the occupied area from the main stronghold of the species east of the Coast Range.

## Amphibians

The limited amphibian population of the Sitkan district includes two invaders from the south, a toad of common and wide-spread occurrence, a newt that is found on many of the southern islands; and one immigrant from the east, a frog that barely enters the district.

The Northern Toad (*Bufo boreas boreas*) is abundant on the coast as far north as Prince William Sound. It has attained this far northern point not only along the mainland coast but on the islands as well. It is on at least all the larger islands in Prince William Sound, those of the Alexander Archipelago, of the Queen Charlotte group, and on Vancouver Island. The wide-spread distribution of this toad is in strong contrast to the inability of any species of frog to become strongly established in the same region. The toad is a western species and may be surmised to have traveled northward along the coast. Just how it reached the many northern islands where it now occurs is not clear; the genus is not represented on any island south of the United States-Canada boundary line, though common enough on the adjacent mainland.

The Western Spotted Frog (*Rana pretiosa*) is the one species of frog that has reached the Sitkan district. It is a common species inland and it has extended its habitat the length of the Stikine River to Sergief Island, at the mouth of that stream. The salt water channels beyond are clearly formidable barriers to farther range extension, barriers that may never be passed; and the restriction of this frog emphasizes the query as to the means by which the toad achieved its present widespread distribution.

The Pacific Coast Newt (*Triturus torosus*) is a coastal species that finds its northern limit in the Sitkan district and that probably reached this region in the same manner as, and together with, the Northern Toad. It has been found on enough of the islands of the Alexander Archipelago to make it seem likely that it occurs throughout the group.

## Summary

The facts that we have marshalled lead to the following conclusions: The fauna and flora of the Sitkan district are of recent establishment there; probably none of the island area was free of ice and occupied by any of this animal and plant life prior to the close of Pleistocene time, and large sections may have become habitable only at a much later date. Local specific or subspecific characters in birds and mammals thus may all have developed since the Pleistocene. The bird species are mostly derived from the coastal region to the southward; these southern species were the first arrivals and have spread over most of the district. A few kinds came in from the north; a few kinds came through mountain passes and valleys from the east, and these are mostly of limited distribution in the eastern portion of the Sitkan district.

Conditions that permitted the spread of birds from the south were unfavorable to most mammals. One southern mammal, the deer, was conspicuously successful in this immigration, and there may have been one or two others, but most of the mammals of the Sitkan district are from the east, whence approach by birds was apparently more difficult. Several northern mammals colonized certain northern islands of the Alexander Archipelago that were most easily accessible from that direction.

The distribution of species over the Alexander Archipelago is to be explained mainly on the basis of the present accessibility of the islands. There is the added suggestion in the observed development of certain species and subspecies (as the Song Sparrow), that the westernmost islands, first to be cleared of their glacial covering, may have been first to be occupied by living things. Depth and width of the separating channels, however, were determined long before, so that with the disappearance of glacial ice, and with the arrival of animal life, these barriers were all functioning as they do today.

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No. 4

# A NEW CENTRAL AMERICAN SNAKE

BY

JOSEPH R. SLEVIN
*Curator, Department of Herpetology,*
*California Academy of Sciences*

Included in a collection of snakes made by the author while a guest of Señor Juan Zenon Posadas at his coffee plantation on the southern slope of the Volcan Zunil, Suchitepequez, Guatemala, is a new species of *Trimetopon*. I take great pleasure in naming this species after my host, who was largely responsible for my success in collecting reptiles and amphibians in that most interesting region. My thanks are due Mr. Karl P. Schmidt and Dr. E. R. Dunn for examining the type specimen; they verified my conclusion that it represents an undescribed species.

## **Trimetopon posadasi** Slevin, new species

*Type.*—No. 66964, Mus. Calif. Acad. Sci. Herpetol. **Southern slope Volcan Zunil, Suchitepequez, Guatemala.** Collected by Joseph R. Slevin, August 8, 1924.

*Diagnosis.* Male: scales in 17 rows; gastrosteges 138; urosteges 92c; anal divided; supralabials 7–7; infralabials 8–8; preoculars 1–1; postoculars 1–1; loreal 1–1; temporals 1+1—1+1; four infralabials in contact with the anterior chin shields; rostral broad and low. Color above uniform dark brown, with two outer scale rows lighter. Under surface uniform yellowish. A distinct yellowish collar band three to three and one-half scales wide engages the posterior tips of the parietals. Total length 276 mm.; tail 94 mm.

*Paratypes.* Four paratypes, C. A. S. Herpetol. Nos. 66962, 66963, 66965, 66966 from the type locality, collected by Joseph R. Slevin, and one, Field Museum of Natural History No. 20420, from Olas de Moca, southern slope of Volcan Atitlan, Solola, Guatemala, collected by F. J. W. Schmidt, March 9, 1934, show that the undersurface of this species may be either yellowish or whitish in coloration; three of the specimens from the type locality and the one from Volcan Atitlan are of the latter color.

SCALE COUNTS OF THE PARATYPES ARE AS FOLLOWS:

| | No. | Sex | Scale Rows | Gastro-steges | Uro-steges | Anal | Supra-labials | Infra-labials | Pre-oculars | Post-oculars | Loreal | Temporals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C. A. S. | 66962 | ♀ | 17 | 147 | 88c | 2 | 7–7 | 8–8 | 1–1 | 1–1 | 1–1 | 1+2—1+2 |
| C. A. S. | 66963 | ♀ | 17 | 139 | 88c | 2 | 7–7 | 8–8 | 1–1 | 1–1 | 1–1 | 1+2—1+2 |
| C. A. S. | 66965 | ♀ | 17 | 144 | 80c | 2 | 7–7 | 8–8 | 1–1 | 1–1 | 1–1 | 1+1—1+2 |
| C. A. S. | 66966 | ♂ | 17 | 142 | 93c | 2 | 7–7 | 8–8 | 1–1 | 1–1 | 1–1 | 1+2—1+2 |
| F. M. N. H. | 20420 | ♀ | 17 | 149 | 93c | 2 | 7–7 | 8–8 | 1–1 | 1–1 | 1–1 | 1+1—1+2 |

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**No. 5**

# THE CRANIUM OF THE MIOCENE GANNET MORIS VAGABUNDUS WETMORE*

BY

LAWRENCE V. COMPTON
*Museum of Paleontology,*
*University of California*

Doctor G. Dallas Hanna, of the California Academy of Sciences, has generously permitted me to examine and report upon a fossil bird cranium from the collection of the Academy. This specimen, Mus. Calif. Acad. Sci. Paleo., No. 1732, is from the upper level of the Temblor Miocene, locality 2134, about eleven miles north of Bakersfield, Kern County, California, N. E. corner of Sec. 28, T. 27 S., R. 28 E., M. D. M., west branch of Granite Creek, collected by J. B. Stevens, 1929.

The specimen (fig. 1) consists of the major part of the posterior portion of the skull. Many of the protruding ridges and processes have been broken away but the occipital region is intact except for the dorsal margin of the foramen magnum. There is an excellent cast of the right lobe, and half of the left lobe, of the cerebrum.

This cranium is that of a gannet and it agrees with those characters of the gannets which separate the latter from the boobies. The crania of the gannets of the genus *Moris* differ from those of the boobies of the genus *Sula* in the following details: In *Moris* the supraoccipital extends from the parietals to the foramen magnum at an angle of about 45 degrees; this bone is only slightly hollowed at its dorsal and lateral margins while its greater portion presents a smoothly rounded convex surface with a median crest only at its

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dorsal margin. In *Sula* the supraoccipital drops abruptly from the parietals to the foramen magnum; it has a general concave appearance and there is at least a trace of a median crest throughout its length. In *Moris* the posterior margins of the exoccipital processes are of a narrow columnar nature while in *Sula* they are thick and squat.

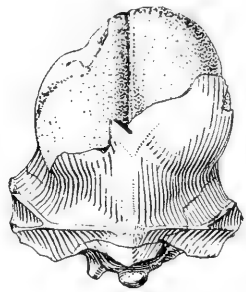

Fig. 1. Dorsal view of the cranium of *Moris vagabundus* Wetmore. Mus. Calif. Acad. Sci. Paleo. No. 1732, natural size.

Wetmore has described (Proc. Calif. Acad. Sci., ser. 4, 19, 1930, p. 89) a gannet, *Moris vagabundus*, from the upper level of the Temblor Miocene. He states that this species is approximately the size of the living Red-footed Booby (*Sula piscator*). The smallest booby that I have had available for comparison is the Brewster Booby (*Sula brewsteri*) which is but slightly larger than *S. piscator*. The fossil specimen under consideration is sufficiently smaller than *S. brewsteri* as to place it in the size range of the fossil species *M. vagabundus*. The specimen comes from the same horizon, the upper level of the Temblor Miocene, as does *M. vagabundus*, but from a locality about seven miles northwest of the locality of the type specimen. I consider the foregoing evidence as sufficient for referring the cranium to *Moris vagabundus*. The fossil differs from the living gannets in having the parietals more swollen in the region of the cerebellum.

There are now known three skeletal elements of this fossil gannet, namely, the type, which is the distal end of the humerus, a fragmentary ulna which was referred to this species by Wetmore (*op. cit.*, p. 91), and the cranium here described.

I am indebted to Doctor Loye Miller, of the University of California at Los Angeles, for the loan, from his personal collection, of a skull of the living gannet *M. bassana*. The drawing was made by Mr. Owen Poe.

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No. 6

# A NEW MEMBER OF THE BLENNY FAMILY

BY

ALVIN SEALE

*Superintendent, Steinhart Aquarium,*
*California Academy of Sciences*

On December 3, 1934, the Steinhart Aquarium of the California Academy of Sciences received a shipment of live fishes from Suva, Fiji Islands. Included among these were two small blennies belonging to the genus *Petroscirtes* Rüppell.

These fishes were about 50 mm. in length, of a uniform bright yellow color, and very active and graceful in their movements.

I placed them in a small salt water aquarium in my office for observation, as I was unable to identify them with any known species. They lived in this tank without any plants or aeration of any sort for more than a month, when a misfortune caused the death of one; the other is still at this date (March, 1935) alive and in good condition. It feeds freely on Artemia, small bits of raw beef or shellfish.

## **Petroscirtes auratus** Seale, sp. nov. The Golden Blenny

The following description is based upon a careful examination of the preserved specimen, which is here made the type of the new species.

Head 4 in length to base of caudal. Depth 4.5. Dorsal 40, the rays about equal in length. Anal 20. No scales nor lateral line. No tentacles. Eye large, 2.7 in head, greater in width than the evenly curved snout. Interorbital space 3.5 in

August 12, 1936

head, being about equal to snout. Top of the head rugose. Teeth flat, sharp, moveable, two very large canines in lower jaw and two small ones in the upper. The teeth $\frac{14}{15}$ in number. Gill openings a short slit above the line of the pectorals. Dorsal continuous, unnotched, its origin slightly in advance of the gill openings, its posterior prostrate ray extending to caudal. Anal fin similar to dorsal, its origin midway between tip of snout and base of caudal. Ventrals jugular, of two rays. Caudal fin large, lyre shaped in life, the tips of the lobes being extended at least a third beyond the other rays, which are at least a third longer than the head. Pectorals less than length of head. Color in life a uniform bright lemon yellow including all fins, except the middle portion of the caudal, which is colorless. In alcohol the color fades to a yellowish white. No spots nor stripes.

*Holotype:* No. 5527, Mus. Calif. Acad. Sci. Ichthyol. Collected by Charles Knudsen at **Suva, Fiji Islands,** Dec. 3, 1934. Length 53 mm.

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**No. 7**

# THE FISHES OF THE ATLANTIC AND PACIFIC SLOPES NEAR CAJAMARCA, PERU*

BY

NATHAN E. PEARSON

*Associate Professor of Zoology*

*Butler University*

From July to September 1923 the writer made a trip across the Western Andes of northern Peru from Pacasmayo to the Rio Marañon to collect fishes. Collections were secured from the Pacific slope and from the Atlantic slope down to an altitude of about 3500 feet. The trip was made for the department of Zoology of Indiana University, under the direction of Dr. C. H. Eigenmann. The government of Peru coöperated by making grants for transportation.

The region between Pacasmayo and the Rio Marañon is very rugged. Several small streams descend precipitously the western slope of the Andes to enter the Rio Jequetepeque. This river descends more gradually and enters the Pacific ocean after running across a very narrow coastal plain. During the dry season most of the water which descends the valley is used for irrigation. The divide between the Atlantic and Pacific slopes lies about 75 miles from the Pacific. Its elevation is nearly 12,000 feet. East of the continental divide the streams descend rapidly to the Rio Marañon, which lies between the two main cordilleras of the Andes at an elevation of about 3500 feet in this region.

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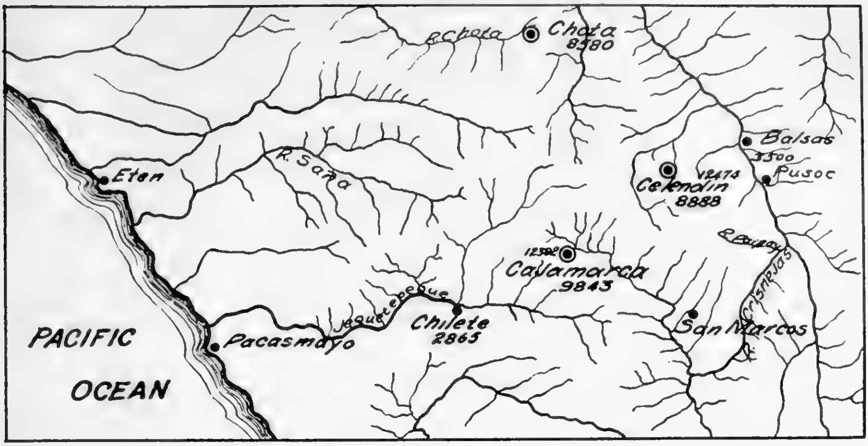
A railway extends from Pacasmayo to Chilete. From Chilete there is a pack train route through Cajamarca, Celendin, Balsas, and Chachapoyas. From Chilete this route leads up the valley of the Jequetepeque for several miles. Then, there is a rapid climb up the continental divide followed by a steep descent into the valley of the Rio Cajamarca. In this valley lies the ancient Inca city, Cajamarca. The Cajamarca valley lies at an elevation of more than 9000 feet. It is three miles wide at its greatest width and fifteen miles long. Several miles below Cajamarca the valley narrows, and the river drops rapidly before entering the Rio Crisnejas which is a tributary of the Marañon. The trail between Cajamarca and Celendin leads along a crest that is slightly higher than the continental divide. From Celendin the trail immediately climbs a third crest. The Marañon at Balsas can be seen from this crest. Seven hours are required for the descent to the river from this point. At Balsas a narrow suspension bridge spans the Marañon. This small village, with about twenty-five inhabitants, has a telegraph station, but no stores. Mail for the interior is met here by arrieros from Chachapoyas.

Fishing at Balsas was difficult. The Marañon is a narrow, swiftly running stream at this point. Two side streams, that entered the Marañon from the highlands, gave better results than the river. The Marañon was fished at two other places, Pusoc, and at the mouth of the Rio Crisnejas. These places could not be reached by traveling up the Marañon. It was necessary to return to the highlands and follow different trails down to the Marañon.

There is no navigation along this part of the river, except on rafts made from balsa wood, and these are used only for crossing the river. The natives are not river-men. Most of them are unable to swim and they fear the river. Their homes are in the more healthful highlands, and they go into the extremely hot and malarial laden valley of the Marañon only in order to tend and harvest crops. With the exception of tropical fruits, there is very little food in the valley. Workers carry food from the highlands with them. The lowland fishes rarely ascend the Marañon to Balsas, and the small Andean forms cannot be depended on for food.

With the exception of the road to Balsas, the trails to the Marañon are known by very few people. They are narrow, poorly constructed, and seldom repaired. Travel over these trails was slow, arduous, and dangerous. The trip to the lower Crisnejas was made less arduous and a pleasure by Señor Napoleon Puga, a Peruvian, who had graduated from Cornell University. He was superintending a part of his family's large holdings of some three million acres along the Rio Crisnejas and Marañon. He had planned to inspect this part of the great hacienda which he had not visited for three years, and welcomed company on the long, lonely trip. His peons under his direction were a great aid.

The usual methods for collecting fishes for scientific purposes were used: seines, the fish poison "cube," dynamite, hook and line, divert-




Text figure 1. Map of the region between Pacasmayo and the Rio Marañon.

ing water from small streams, etc. The fish poison "cube" gave the best results. Preservation was in alcohol, or in formalin from which the specimens were transferred to alcohol.

Most of the fishes taken on the trip were small species typical of the Andean highlands. One species, *Lebiasina bimaculata* Cuvier and Valenciennes, is common to the Atlantic and Pacific slopes. Eigenmann discussed the distribution of this species in Science; Vol. LVIII, 1923, No. 1513, page 532. This mountain species is also found on the Pacific slope of Ecuador, but it had not previously been taken from the eastern slope. The species may have been carried across the divide by human agency. The early Indians were, no doubt, attracted by its beauty and vitality. The species can live for a long time in a minimum quantity of water. This would permit living specimens to be carried in small containers from the Pacific slope to the Cajamarca valley. Near Cajamarca there are a number of clear pools that are said to have been in existence before the conquest of Peru by Pizarro. These could have served for aquaria, and they would have been an incentive to carry these attractive fishes across the divide. If the species has been carried across the divide recently, it may be restricted in its distribution along the eastern slope.

The descriptions for the following species of characins which belong to the subfamily Tetragonopterinae, were included in:

Eigenmann: The American Characidæ, Memoirs Museum Comparative Zoology Harvard, Vol. XLIII, part IV, 1927, and part V, with Myers, 1929.

*Moenkhausia crisnejas* Pearson, part V, page 524.
*Hemigrammus paipayensis* Pearson, part V, page 533.
*Microgenys lativirgatus* Pearson, part IV, page 355.

## Collection Localities

1. Cajamarca, 9843 feet.
2. Balsas, 3500 feet.
3. Pusoc, also called Guayabamba, above Balsas, about 3700 feet.
4. Huagal, at the head of the Rio Paipay, about 10,000 feet.
5. Paipay, at the mouth of the Rio Paipay, about 3900 feet.
6. Rio Crisnejas above Paipay, about 4000 feet.
7. Tingo de Pauca, at the mouth of the Rio Crisnejas, about 3800 feet.
8. Above Chilete, about 4000 feet.
9. Lagoon Hornito, above Pacasmayo.
10. Pacasmayo.

## List of the Fishes of the Atlantic and Pacific Slopes near Cajamarca, Peru

The numbers refer to catalogue numbers in the Indiana University collection. These numbers are also used in the Ichthyological collection of the California Academy of Sciences, the Indiana University collection having been transferred to the Academy in 1929.

### Family Characinidae

#### Subfamily Prochilodinae

1. **Prochilodus nigricans** Agassiz, 1829. 17662, 2, 300 and 310 mm., Paipay, Rio Crisnejas. September.

#### Subfamily Lebiasininae

2. **Lebiasina bimaculata** Cuvier and Valenciennes, 1846. 17587, 19, 40–180 mm., Pacasmayo, Peru. September; 17588, 23, 23–108 mm., above Chilete, Peru. September; 17589, 4, 42–85 mm., Cajamarca, Peru. July; 17590, 66, 32–122 mm., Paipay, Rio Crisnejas, Peru. August.

The distribution of this species was discussed in the introduction.

#### Subfamily Bryconinae

3. **Brycon stolzmanni** Steindachner, 1879. 17596, 32, 137–206 mm., Balsas, Peru. July; 17597, 67, 32–83 mm., Paipay, Rio Crisnejas, Peru. August; 17598, 33, 26–52 mm., Tingo de Pauca, Rio Marañon, Peru. September; 17599, 96, 26–44 mm., Pusoc, above Balsas, Peru. August.

The type specimens of this species were taken at Chota, which is located on a tributary of the Marañon a few miles below Balsas, Peru.

4. **Brycon atricaudata** (Kner), 1863. 17593, 4, 186–195 mm., Lagoon Hornito, Pacasmayo, Peru. September; 17594, 3, 135–147

mm., mouth of Jequetepeque, Pacasmayo, Peru. September; 17595, 17, 38–88 mm., above Chilete, Peru. September.

Subfamily Tetragonopterinae

5. **Moenkhausia crisnejas** Pearson, 1929. 17641, 26, 34–44 mm., Paipay, Rio Crisnejas, Peru. August.

6. **Knodus breviceps** (Eigenmann). 1908. 17612, 21, 29–59 mm., Tingo de Pauca, Rio Marañon, Peru. September; 17613, 13, 33–40 mm., Rio Pusoc, above Balsas, Peru. August.

7. **Knodus moenkhausii** (Eigenmann and Kennedy), 1903. 17614, 1, 68 mm., Rio Pusoc, above Balsas, Peru. August.

8. **Hemigrammus paipayensis** Pearson, 1929. 17643, many, 32–50 mm., Paipay, Rio Crisnejas, Peru. August; 17644, 12, 32–38 mm., Rio Pusoc, above Balsas, Peru. July.

9. **Astyanax bimaculatus** Linnaeus, 1758. 17607, 26, 33–94 mm., Paipay, Rio Crisnejas, Peru. September, 17608, 1, 74 mm., Rio Pusoc, above Balsas, Peru. August.

10. **Astyanax maximus** (Steindachner), 1875. 16019, 1, 181 mm., Rio Pusoc, above Balsas, Peru. August; 16020, 11, 125–158 mm., Tingo de Pauca, Rio Marañon, Peru. September.

11. **Microgenys lativirgatus** Pearson, 1927. 17642, 4, 56–71 mm., Rio Pusoc, above Balsas, Peru. August.

12. **Bryconamericus peruanus** (Müller and Troschel), 1845. 17591, 93, 33–80 mm., Pacasmayo, Peru. September; 17592, 10, 24–65 mm., above Chilete, Peru. September.

13. **Bryconamericus alfredae** Eigenmann, 1927. 17615, 14, 32–66 mm., Paipay, Rio Crisnejas, Peru. August.
The larger specimens have about 12 weak conical or tricuspid teeth along the greater part of the maxillary border. In the young the distal teeth have not developed.

14. **Bryconamericus caucanus** Eigenmann, 1913. 17603, many, 40–88 mm., Balsas, Peru. July; 17604, 138, 32–58 mm., Paipay, Rio Crisnejas, Peru. August; 17605, 4, 34–82 mm., Tingo de Pauca, Rio Marañon, Peru. September; 17606, 1, 41 mm., Rio Pusoc, above Balsas, Peru. August.

15. **Hemibrycon huambonicus** (Steindachner), 1882. 17609, 2, 62–63 mm., Paipay, Rio Crisnejas, Peru. August; 17610, 30, 64–88 mm., Balsas, Peru. July.

16. **Hemibrycon helleri** Eigenmann, 1927. 17611, 1, 65 mm., Paipay, Rio Crisnejas, Peru. September.

17. **Hemibrycon jelskii** (Steindachner), 1875. 17640, 54, 30–40 mm., Rio Pusoc, above Balsas, Peru. August.

18. **Creagrutus beni** Eigenmann, 1911. 17600, 29, 43–74 mm., Balsas, Peru. July; 17601, 12, 31–70 mm., Tingo de Pauca, Rio Marañon. Peru. September; 17602, 83, 28–56 mm., Paipay, Rio Crisnejas, Peru. August.

### Subfamily CHARACINAE

19. **Eucynopstamus gulo** (Cope), 1870. 17616, 9, 124–196 mm., Tingo de Pauca, Rio Marañon, Peru. September; 17617, 2, 60–128 mm., Pusoc, above Balsas, Rio Marañon. Peru. August.

### Family GYMNOTIDAE

20. **Sternarchus hasemani** Ellis, 1913. 17618, 15, 71–291 mm., Tingo de Pauca, Rio Marañon, Peru. September; 17619, 1, 154 mm., Paipay, Rio Crisnejas, Peru. September.

21. **Sternopygus macrurus** (Bloch and Schneider); 1801. 17620, 1, 186 mm., Pusoc, above Balsas, Rio Marañon, Peru. August; 17621, 1, 317 mm., Tingo de Pauca, Rio Marañon, Peru. September.

### Family PIMELODIDAE

22. **Pseudopimelodus pulcher** Boulenger, 1887. 17625, 1, 101 mm., Tingo de Pauca, Rio Marañon, Peru. September.

23. **Pimelodus ornatus** Kner, 1857. 17635, 1, 486 mm., Balsas, Peru. July; 17636, 2, 337 and 450 mm., Rio Marañon at Pusoc, above Balsas. August.

24. **Pimelodella gracilis** (Valenciennes) 1847. 17626, 28, 54–212 mm., Tingo de Pauca, Rio Marañon, Peru. September; 17627, 3, 155–157 mm., Pusoc, Rio Marañon, above Balsas. August.

25. **Pimelodella yuncensis** Steindachner, 1902. 17628, 22, 24–65 mm., above Chilete, Peru. September; 17629, 3, 48–54 mm., Pacasmayo, Peru. September.

26. **Imparfinis bolivianus** Pearson, 1924. 17632, 2, 42 and 53 mm., Pusoc, Rio Marañon, above Balsas, Peru. August.

27. **Nannorhamdia longicauda** (Boulenger), 1887. 17630, 41, 37–88 mm., Tingo de Pauca, Rio Marañon, Peru. September; 17631, 6, 32–78 mm., Paipay, Rio Crisnejas, Peru. August.

This species was figured and described by Boulenger from four specimens as *Pimelodus* (*Rhamdia*) *longicauda*. They were taken at

Canelos, Ecuador. Boulenger did not describe the fontanels. Eigenmann and Eigenmann referred the specimens to *Rhamdia*. They have since been referred to *Nannorhamdia*, but differ by not having a free orbital margin.

Head covered with skin; occipital process short; fontanel extending to the base of the occipital process, a narrow bridge crossing it at the level of the posterior margin of the eye; the length of the adipose disagrees with that given in the description but agrees with the figure, 3.25–3.7 in the length measured to the base of the caudal; otherwise as in Boulenger's description.

### 28. **Chasmocranus quadrizonatus** Pearson, new species

*Holotype:* No. 17659, Mus. Calif. Acad. Sci., Ichthyol., 35 mm., **Tingo de Pauca, Rio Marañon, Peru.** Sept.; and paratype: No. 17660, 28 mm., Pusoc, Rio Marañon, Peru. Aug.

Head 4.3; depth 5.4; D. 7.5; A. 11; width of head slightly less than its length; eye 5 in the head, 2 in the snout, 1.8 in the interocular space, without a free orbital margin; head rounded; tail compressed; tip of the occipital crest much nearer the dorsal than to the tip of the snout; fontanel long and narrow, interrupted above the posterior third of the eye; anterior nostril much nearer the tip of the snout than to the posterior nostril; upper jaw slightly the longer; premaxillary band of teeth about 3.2 in its length; maxillary barbels extending to the posterior third of the pectorals, outer mentals to the gill opening, inner mentals not quite so long; base of mental barbels in a straight line, their distance from the edge of the lower lip less than the distance between them; distance of the dorsal from the tip of the snout about 2.4 in the length, the spine not pungent, the rays from the first gradually decreasing in height; pectorals about equal to the head in length, extending to the base of ventrals, the spine not pungent; origin of the ventrals below the second dorsal ray; origin of the anal under origin of the adipose; caudal forked, the lobes of about equal length; adipose 4.5 in the length.

A narrow light band just back of the head and above the gill openings; the back with 4 wide dark brown bands, the first in front of the dorsal, the second extending from the posterior two-thirds of the dorsal to the tip of the depressed dorsal, the third through the middle of the adipose, the fourth is at the base of the caudal; the bases of the upper and lower caudal lobes with a white spot. The smaller specimen from Pusoc unmarked.

## Family PYGIDIIDAE

29. **Pygidium taczanowskii** (Steindachner), 1882. 17645, 13, 96–203 mm., Tingo de Pauca, Rio Marañon, September; 17646, 10, 31–101 mm., and 2, 234 and 270 mm., Balsas, Peru. July.

All of No. 17645 agree with Steindachner's description and figure except a single specimen. It differs by having a wide dark streak extending from the angle of the gill opening to the middle of the base of the caudal; a second lighter and narrower stripe extends just below the dorsal fin from the head, fading out between the dorsal and the caudal base; the general background is light.

The smaller specimens from No. 17646 agree with the striped specimen described above, except for the median lateral stripe, which extends to the end of the caudal. The larger specimens have the head, back, and sides with irregular dark spots.

30. **Pygidium punctulatum piurae** Eigenmann, 1922. 17638, 26, 44–137 mm., above Chilete, Peru. September; 17639, 31, 43–75 mm., above Pacasmayo, Peru. September.

31. **Pygidium rivulatum** (Cuvier and Valenciennes), 1846. 17637, many, 42–77 mm., Cajamarca, Peru. July.

## Family Cetopsidae

32. **Cetopsis plumbeus** Steindachner, 1882. 17623, 3, 71–91 mm., Tingo de Pauca, Rio Marañon, Peru. September; 17624, 1, 55 mm., Pusoc, above Balsas, Rio Marañon, Peru. August.

## Family Astroblepidae (Argidae)

33. **Astroblepus peruanus** (Steindachner), 1879. 17648, many, 26–64 mm., Huagal, Peru. August; 17649, many, 24–62 mm., Cajamarca, Peru. August.

34. **Astroblepus rosei** Eigenmann, 1922. 17647, 36, 24–85 mm., above Chilete, Peru. September.

35. **Astroblepus longifilis** (Steindachner), 1882. 17663, 1, 27 mm., Balsas, Peru. July.

### 36. **Astroblepus supramollis** Pearson, new species

Plate 13, fig. 3

*Co-types:* No. 17650, Mus. Calif. Acad. Sci., Ichthyol., many, 24–80 mm., **Balsas, Peru.** July; No. 17651, 31 specimens, 46–80 mm., Balsas, Peru. July; No. 17652, 36 specimens, 50–75 mm., Tingo de Pauca, Rio Marañon, Peru. September.

The general appearance is that of *A. sabalo* (Cuvier and Valenciennes). None of the specimens indicate, however, that the adipose fin would be as high as those found in large specimens of *A. sabalo;* they are very close to *A. trifasciatus* (Eigenmann) in this respect and in the nature of the markings. Steindachner figured *A. sabalo* with a high adipose and with marbled markings; none of the above larger specimens show the marbled markings; they are spotted or uniformly brown. Those of No. 17651 have the body entirely without markings.

The larger specimens are sexually mature. In life they had a transparent jelly-like substance beneath the skin on top of the head and in front of the dorsal. In the preservative the substance disappeared and the skin became wrinkled.

Head 3–3.3; depth 5.8–6.4; D.7; A.7; interocular width slightly less than the distance between the eye and the posterior nostril, approximately 4.2 in the head; nasal flap triangular, produced in a small barblet in the larger specimens, maxillary barbel lacking about 0.7 of its length reaching the gill opening; premaxillary teeth compressed, the outer series mostly unicuspid, a few near the symphysis Y-shaped, the tips narrowly rounded; mandible with fewer teeth, all Y-shaped; pectoral spine produced into a filament, the spine and filament extending to about the second fifth of the ventrals; origin of the ventrals considerably in advance of the dorsal; ventrals not quite reaching the anal opening; anal opening about 0.7 of the distance between the origin of the ventrals and the base of the anal; anal not near reaching the base of the caudal when depressed; outer caudal rays produced; adipose spine movable, well developed, connected to the back by a thin membrane, its length greater than the interocular width; the part of the adipose fin in advance of the base of the spine low, not fleshy, in some specimens scarcely distinguishable; dorsal spine 1.5–1.7 times in the head, only slightly produced; distance of the dorsal from the tip of the snout about 2.1 in the length.

The young marbled, usually with a light band just in front of the dorsal followed by a wide band which reaches to the tip of the depressed dorsal, then follow four light and dark bands that vary in width; in the larger specimens the light bands become spotted and frequently uniformly clouded. Caudal usually irregularly spotted, in the larger specimens the posterior half becomes sooty. Dorsal in the young with 1 or 2 rows of spots which become indistinct in the larger specimens.

## 37. **Astroblepus labialis** Pearson, new species

Plate 13, fig. 4

*Co-types:* No. 17653, Mus. Calif. Acad. Sci., Ichthyol., 7 specimens, 47–71 mm. **Balsas, Peru.** July.

Characterized by the very wide lips.

Head 3.3–3.6; depth 5.3–6; D.7; A.7; interocular slightly less than the distance between the eye and the posterior nostril, 3.8–4 times in the head; nasal flap triangular, moderate, not produced; premaxillary teeth compressed, the tips rather narrowly rounded, mostly unicuspid with a few Y-shaped teeth at the symphysis; barbels not near reaching gill opening, lacking approximately one-half their length of extending to the gill opening; pectoral spine slightly produced, the spine with the filament extending almost to the tip of the ventrals in some specimens, only to the middle of the ventrals in the others; origin of the ventrals considerably in advance of the dorsal; the extent of the ventrals variable, usually three-fourths of the distance to the anal opening; depressed anal not quite reaching the caudal; caudal deeply emarginate, the outer caudal rays only slightly produced, adipose fin low, weakly developed; adipose spine movable, connected to the back by a narrow thin membrane, its length equals the interocular width; dorsal spine 1.3 in the length of the head; the distance of the origin of the dorsal from the tip of the snout 2.33 in the total length.

Back with a well defined dark streak, the body otherwise uniformly light brown; the base of the caudal dark; dorsal spine and outer caudal rays spotted, the caudal rays dusky.

## Family LORICARIIDAE

38. **Plecostomus plecostomus** Linnaeus, 1758. 17658, 1, 88 mm., Pusoc, above Balsas, Rio Marañon, Peru. August.

39. **Chaetostomus brevis** Regan, 1904. 17633, 30, 38–101 mm., Balsas, Peru. July; 17634, 26, 48–102 mm., Tingo de Pauca, Rio Marañon, Peru. September.

Several specimens have the anal 1.5, and in this respect agree with *C. dermorhynchus* Boulenger. Some of the smaller specimens may represent another species.

### 40. **Chaetostomus mollinasus** Pearson, new species

Plate 13, figs. 1 and 2

*Co-types:* No. 17654, Mus. Calif. Acad. Sci., Ichthyol., 8 specimens, 37–68 mm., **Balsas, Peru.** July; No. 17655, 5 specimens, 41–53 mm., Cajamarca, Peru. July.

Characterized by the nature of the snout. The larger specimens when alive have a soft jelly-like roll which borders the snout. It extends from the interopercula, becoming larger anteriorly. In the preservative the jelly-like substance disappears leaving a superfluous amount of skin on the snout.

In the following measurements the soft snout is not included.

Head 3–3.3; depth approximately 6; D.I.9; A.I.3; head slightly broader than long, 2.2 as long as deep; eye approximately 8 in the head, 2.5 in the interorbital width; interorbital 3.25–3.5 in the head, snout 1.6 times; length of the mandibular ramus slightly greater than the interorbital width; interoperculum with 9–11 short spines; 23–24 scutes in a longitudinal series; 9 or 10 between the anal and the caudal; dorsal slightly rounded, the spine about equal to the snout in length; length of the dorsal slightly less than its distance from the base of the middle caudal rays; adipose fin small, well developed; pectoral spine just reaching base of ventral; caudal peduncle 2–2.2 as long as deep.

Color, olive brown when preserved in alcohol, light brown in formalin; dorsal and anal with 4 or 5 rows of spots, the spots irregular on the caudal.

### 41. **Loricaria puganensis** Pearson, new species

*Co-types:* No. 17656, Mus. Calif. Acad. Sci., Ichthyol., 10 specimens, 86–141 mm., **Pusoc, Rio Marañon,** Peru. Aug.; No. 17657, 5 specimens, 123–220 mm., Tingo de Pauca, Rio Marañon, Peru. Sept.

Closely related to *Loricaria gymnogaster* Eigenmann, differing chiefly in the greater body width and the lesser length.

Head 4.2–4.5; depth 7.8–9.2; D.I.7; A.I.5; breadth of head 1.24–1.3 in its length, eye 6.5–7, interorbital approximately 4.5, snout 1.8; head slightly roughened; snout pointed; the supraoccipital without a keel; orbit with a broad shallow notch;

lips with well developed papillæ, becoming smaller and less distinct posteriorly, margined posteriorly with short fringes, the fringes much longer anteriorly; lower lip slightly emarginate; barbel extending to the posterior margin of the lip; 31–32 scutes in a longitudinal series, the lateral keels united on the last 7 or 8 plates; lower surface of the head naked; abdomen in advance of the ventrals with small granular plates, between the base of the ventrals and ventrals naked; an enlarged plate in front of anal opening, usually it is broken in 2 or 3 plates; breadth of body at the level of first anal ray 3.1–3.4 times in the distance from that point to the caudal; dorsal spine 1.3 in the length of the head; pectoral spine extending to the second third of the ventral; upper caudal ray with a filament somewhat longer than the body.

Back with 4 cross bars; all fins spotted, the spots on the rays; the spots frequently run into bands on the caudal.

Named in honor of Señor Napoleon Puga who aided in the work along the Rio Crisnejas.

## Family MUGILIDAE

42. **Agonostomus monticola** (Bancroft), 1836. 17661, many, 31–70 mm., Pacasmayo, Peru. September.

## Family CICHLIDAE

43. **Aequidens rivulatus** (Günther), 1859. 17585, 12, 38–130 mm., Lagoon Hornito, Pacasmayo, Peru. September; 17586, 15, 15–138 mm., above Chilete, Peru. September.

## Plate 12

Fig. 1. The Rio Crisnejas at the junction of the Paipay.

Fig. 2. The Rio Marañon near Pusoc, above Balsas.

## Plate 13

Fig. 1. *Chaetostomus mollinasus* Pearson, new species. Co-type. No. 17654, 68 mm. Balsas, Peru.

Fig. 2. *Chaetostomus mollinasus* Pearson, new species. Ventral view of same co-type.

Fig. 3. *Astroblepus supramollis* Pearson, new species. Co-type. No. 17650, Balsas, Peru.

Fig. 4. *Astroblepus labialis* Pearson, new species. Co-type. No. 17653, 71 mm. Balsas, Peru.

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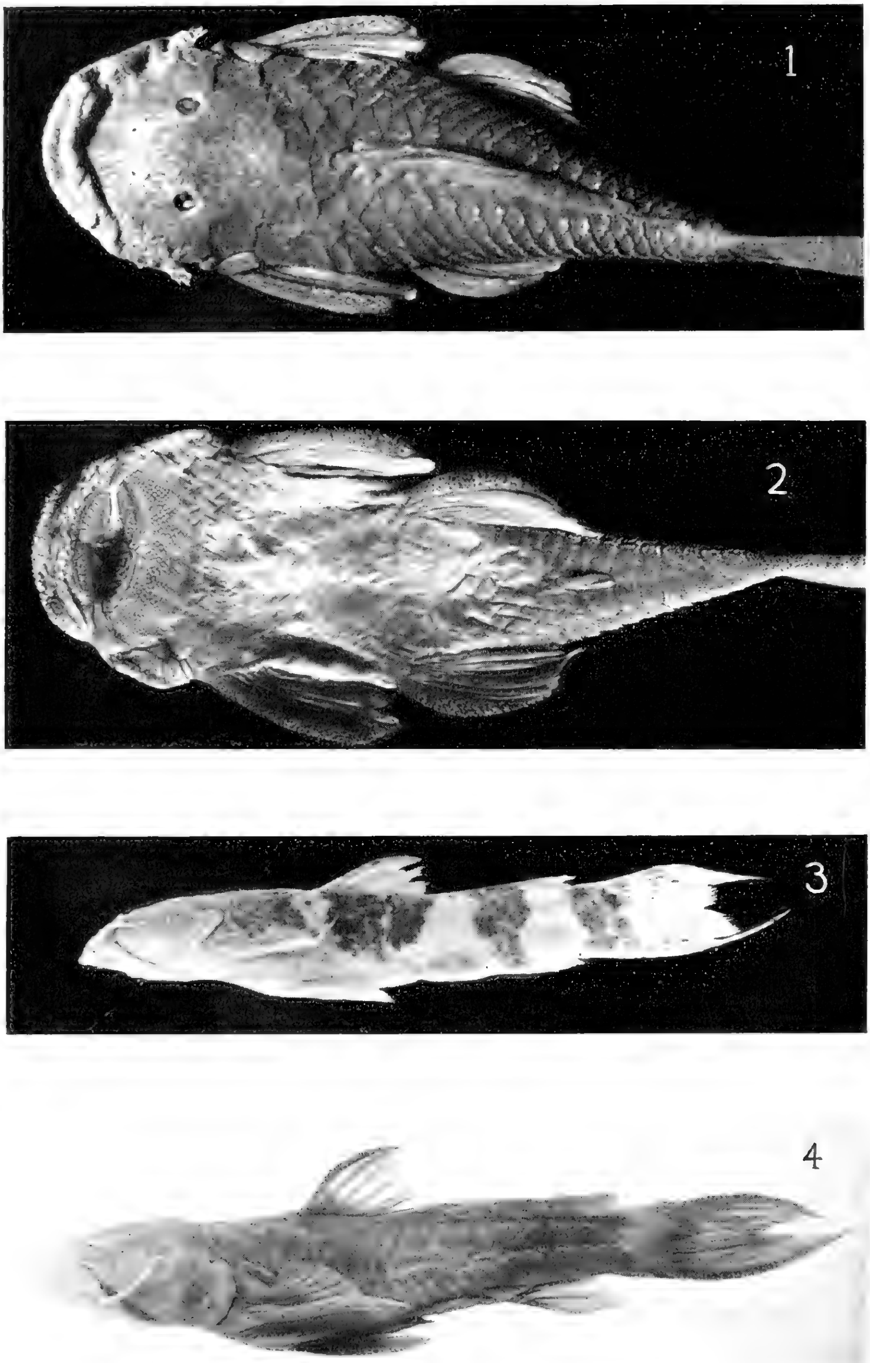
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**PROCEEDINGS**

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**No. 8**

# THE FISHES OF THE BENI-MAMORÉ AND PARAGUAY BASINS, AND A DISCUSSION OF THE ORIGIN OF THE PARAGUAYAN FAUNA*

BY

NATHAN E. PEARSON

*Associate Professor of Zoölogy*

*Butler University*

The resemblance of the freshwater fish fauna of the La Plata to that of the Amazon basin has been known since the earliest collections were made in those regions. During the past fifty years the identification of a great amount of material taken from numerous localities in those river systems has further emphasized this similarity.

Jordan ('96) pointed out that the marshy character of the upland between the Tapajos and the Paraguay would permit the free movement of fishes between the two basins. Eigenmann ('06) and Eigenmann, McAtee, and Ward ('07) directed attention to the low nature of the divide between the Guaporé and some of the principal headwaters of the Paraguay and suggested this as a possible migratory route.

Haseman ('12) was unable to account for the remarkable similarity of the freshwater fish fauna in many of the smaller river basins whose headwaters are near those of the Amazon, by migration of forms now existent in the Amazon, and used the Paraguay and Amazon basins as examples to illustrate the hypothesis of parallel evolution as applied to the South American freshwater fish problem.

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Eigenmann and Eigenmann ('91), and Eigenmann ('09) compared the then known faunas of the La Plata and Amazonian systems. Eigenmann, McAtee, and Ward ('07) compared the rather completely known fauna of the Paraguay with that of the Amazon. No study, however, has been made of the relationship of the fauna of any of the northern affluents of the La Plata and southern affluents of the Amazon whose headwaters intermingle on the highlands of Matto Grosso. This has been due to a lack of knowledge of the nature of the complete fauna from any of the southern affluents of the Amazon. During the past twenty-five years the identification of large collections taken from the Beni, Guaporé, and Mamoré basins has made this region well known ichthyologically, and a comparison of the fauna of the Paraguay with that of the Beni-Mamoré is now possible.

The close similarity of the Beni-Mamoré to the Paraguay in size, physical, geographical, and geological features has given many environments that are practically identical. The two systems apparently differ only in respect to the smaller size and more tropical position of the former, and the slightly lower altitude of the latter. These similar conditions, the rich faunas of the two basins, and the lowland divide between them, which is older than the South American freshwater fish fauna, make a comparison of the two regions doubly interesting.

As yet the faunas of the Xingu, Tapajos, and Tocantins are imperfectly known.

This report was made as a part of the general plan for the study of the problem of the distribution of the South American freshwater fishes as outlined by Eigenmann ('06 and '09). The first intensive work under this plan was done in British Guiana, followed by Columbia, and the western slopes of the Andes. After exhaustive work in these regions, attention was turned to the problem on the eastern slope of the Andes, which had been started several years previously. Large collections had been made and were being identified, monographs were being prepared and the work was well under way at the time of Dr. Eigenmann's death on April 24, 1927.

The collections made by Dr. Carlos Ternetz in the Tocantins will greatly increase the knowledge of the fishes of that basin when they are studied. Dr. Ternetz, who was an unusually expert fish collector, collected for Dr. Carl H. Eigenmann from September 1923 to May 1925 in the Tocantins, Lower Amazon, Rio Negro, Cassiquiare and Orinoco. This is one of the largest fish collections to come out of South America and is probably second only to the Agassiz collections that were made during the Thayer Expedition to Brazil. The Ternetz collection was acquired by the California Academy of Sciences along with the entire Indiana University fish collection, and is now located in the Museum of that institution in San Francisco.

## Physical and Geological Features

The Beni-Mamoré drain an area slightly smaller than the Paraguay. Both rivers extend into the eastern slope of the Bolivian Andes. Each drains a part of the highlands of Matto Grosso and large parts of the Gran Chaco, which is the low broad plain of northern Argentina, Paraguay, and southeastern Bolivia. The Beni-Mamoré system extends farther south than any other part of the Amazonian system. Between 14 and 19 degrees it has the same latitude as the Paraguay.

The Beni-Mamoré system is composed of three large converging streams, the Beni, Mamoré, and the Guaporé. The Beni and the Mamoré have their sources in the Andes near La Paz and Cochabamba respectively. The Beni is fed chiefly by streams from the Andes, whereas the Mamoré receives many tributaries from the grassy plains of Bolivia. Both of the latter streams run across alluvial deposits of Quaternary age for the greater part of their course; then they flow over Archaean rocks at Cachuela Esperanza and Guajua Mirim. Below these falls, at Villa Bella, the streams unite to form the Madeira river. At this point the altitude is approximately 450 feet. Above the falls, the Beni and Mamoré rivers are navigable by steam launches to the foothills of the Andes. The Guaporé has its source on the highlands of Matto Grosso near some of the headwaters of the Paraguay and receives many short streams flowing from Serra dos Parecis.

The converging headwaters of the Paraguay after a short course over the level campos of the highlands of Matto Grosso drop quickly to an altitude of about 700 feet. In some streams this drop is completed not more than 100 miles from their sources. After the rivers leave the highlands, they are navigable by steam launches to the mouth of the La Plata. For the greater part of its course the Paraguay runs through swamps and marshes on alluvial deposits of Quaternary age. It joins the Parana at an altitude of about 150 feet. Many short tributaries are received from the east. Their sources are in the Triassic and Cretaceous formations of the southern extension of the highlands between the Parana and Paraguay rivers. From the west the Paraguay receives its longest and largest tributary, the Pilcomayo. It arises within a few miles of some of the Andean sources of the Mamoré, flows southeastward across the Gran Chaco to join the Paraguay near Asuncion.

The following quotations describe the highlands of Matto Grosso over which the fishes of the Amazon are supposed to have had access to the Paraguay:

Reclus ('95), page 252, says:

"The divide between the sources of the Guaporé and the headwaters of the Paraguay scarcely exceeds 1650 feet in altitude, and the Brazilian uplands appear to be connected with those of the Chiquitos territory only by a very narrow isthmus of ancient rocks. Here is the true geographical centre of South America.

"On the maps a continuous chain of mountains is traced between the Madeira and Tapajoz basins, then between the Tapajoz and Paraguay, and lastly between the Tapajoz and the Araguaya. Yet it is certain that this semi-circular ridge has but a fragmentary existence. The heights dominating the plains of the Upper Paraguay and its affluents are in reality merely the escarpments of a plateau disposed in horizontal or very slightly inclined strata, and eroded by the streams now descending towards the Amazons. The rampart itself has a mean elevation of no more than 1650 feet, and above the edge of the plateau rise a few isolated crests, attaining here and there a height of some 3000 feet.

"Thus the orographic system of the Matto Grosso watershed indifferently called 'cordilheria' or 'campos' dos Parexi, from the local tribe, presents a mountainous aspect, only as seen from the south. On this steep side the face of the escarpment is carved into rocky walls, sharp peaks, or needles. But on the opposite side, facing the Tapajoz and Zingu basins, nothing is seen except a long gently inclined slope gradually merging in the Amazonian plains."

On page 254 Reclus ('95) continues:

"Another remarkable phenomenon is the intermingling of its (Paraguay) farthest headstreams with those of the Amazon's affluents. The Jauru, former frontier stream between the Spanish and Portuguese possessions, approaches so near to the Guaporé that it was found easy to connect the two systems by an artificial canal. The Aguapehy affluent of the Jauru is separated from the Alegre, which joins the Guaporé near Matto Grosso, only by a narrow isthmus of slight elevation, and not more than half a mile wide. In 1772 a canal was cut through the divide, large enough to admit a six-oared boat, and other attempts to establish a permanent communication between the two waterways have failed only through lack of sufficient traffic to support such works."

Hartt ('70), pages 503-504, states:

"The rivers Xingu, Tapajos and Paraguay all take their rise in this plain within a few miles of one another near Diamontino, and the watershed is so low that wooden canoes ascend the Tapajos from Santarem, cross over, and embark on the Paraguay, descending to Villa Maria." This plain, according to Hartt, who quotes from Chandless, "has nothing of a mountainous character. It is simply a high range of country varying but little in its general elevation though deeply grooved by the valleys of the rivers."

## Distributional Data

In the following consideration the freshwater forms that are marine in character and, consequently, whose distribution does not depend upon fresh water are not included. Reference to the distribution list will show that only a very few such species exist.

The following table gives a summary of the fishes that are found in the Paraguay and the Beni-Mamoré basins:

| | *Families* | *Genera* | *Species* |
|---|---|---|---|
| Taken from Beni-Mamoré | 21 | 141 | 275 |
| Taken from Paraguay | 21 | 138 | 307 |
| Common to Paraguay and Beni-Mamoré | 18 | 86 | 120 |
| Common to Paraguay and entire Amazon | 21 | 122 | 176 |
| Common to Beni-Mamoré and entire La Plata | 19 | 99 | 121 |
| Taken from Paraguay but not from Beni-Mamoré | 3 | 52 | 187 |
| Taken from Paraguay but not from Amazon basin | 0 | 16 | 131 |
| Taken from Beni-Mamoré but not from La Plata | 3 | 42 | 154 |

The above table shows, as might be expected from the agreement in physical features, that the two basins are nearly equally rich in genera. The slightly larger Paraguay basin contains a few more species than the Beni-Mamoré.

*Beni-Mamoré Basin.* Three families, Cetopsidae, Astroblepidae, and Electrophoridae, are found in the Beni-Mamoré that have not been taken in the Paraguay. Cetopsidae have been reported from elsewhere in the La Plata and might be expected in the Paraguay. The Astroblepidae are strictly an Andean family, and a collection from the upper reaches of the Pilcomayo would undoubtedly contain representatives. The Electrophoridae contain a single genus which includes the electric eels; these forms seem not to be represented in the La Plata basin.

Of the 141 genera found in the Beni-Mamoré, 86, or 61 per cent, are found in the Paraguay; 13 of the remaining 55 genera are found elsewhere in the La Plata basin. Thus 99, or 70 per cent, of the genera are common to the Beni-Mamoré and La Plata basins. Of the 42 genera that have been found in the Beni-Mamoré that have not been found in the La Plata, *Acrobrycon*, *Hemibrycon*, and *Astroblepus* are Andean forms, and might be expected in the Andean headwaters of the Pilcomayo. Of the remaining 39 genera, 18 contain a single species; each of the remaining 21 genera contain fewer than ten species.

Of the 275 species found in the Beni-Mamoré, 120, or 43.6 per cent, have been taken in the Paraguay. Of the remaining 155 found in the Beni-Mamoré only a single species has been reported from elsewhere in the La Plata.

The above data indicate that the fishes of the Beni-Mamoré do not have free access to the Paraguay at the present time. The divide between the Guaporé and the Paraguay acts as a barrier to more than half of the specific fauna of the Beni-Mamoré.

The important genera that are found in the Beni-Mamoré system have had access to the La Plata system. This access seems to have been during relatively recent times, inasmuch as the genera which have been found in the Beni-Mamoré and not in the La Plata are, for the most part, small and unimportant. Sufficient time has elapsed, however, for the independent derivation of more than half of the specific fauna of the Beni-Mamoré.

It is interesting to note here, the relation of the fauna of the Beni-Mamoré to that of the Amazon. Five, or 3.5 per cent, of the genera, all of which contain a single species, and 54, or 19 per cent, of the species found in the Beni-Mamoré have not been found elsewhere in the Amazon basin.

*Paraguay Basin.* Eighteen families are common to the Paraguay and Beni-Mamoré basins. Three families, Hypophthalmidae, Aspredinidae, and Poeciliidae, have been taken from the Paraguay that have not been found in the Beni-Mamoré. The first family is present, no doubt, somewhere in the Beni-Mamoré. The second family is represented by a single species in the Paraguay, *Dysichthys australe*, which Haseman ('11) considered synonymous with *Bunocephalus rugosus*. This species belongs to the Bunocephalidae, which is represented in the Beni-Mamoré. The third family should have been found somewhere in the Beni-Mamoré.

Of the 138 genera found in the Paraguay 86, or 62.3 per cent, are also found in the Beni-Mamoré; 36 of the remaining 52 genera are found elsewhere in the Amazon basin. Thus 122, or 85.5 per cent, of the genera are common to the Paraguay and Amazon basins. Of the 16 genera that are found in the Paraguay that have not been taken anywhere in the Amazon, *Paravandellia*, *Mixobrycon*, *Bertoniolus*, *Piabarchus*, and *Neofundulus* are each known from a single type specimen. *Mimagoniates*, *Vesicatrus*, *Branchioica*, and *Rivulichthys* contain single species from restricted localities. The remaining 7 genera are more or less widely distributed in the La Plata basin; one contains a single species; two contain two species; and four contain three species.

Of the 307 species found in the Paraguay 120, or 39 per cent, have been taken in the Beni-Mamoré. Of the remaining 187 species found in the Paraguay 56 have been found elsewhere in the Amazon. Thus a total of 176, or 57.3 per cent, of the species found in the Paraguay are also found somewhere in the Amazon basin. This leaves 131, or 43 per cent, that are found in the Paraguay basin but not anywhere in the Amazon.

The above data indicate that the Paraguay has not secured that part of its fauna which it has in common with the Amazon basin from the fauna now present in the Beni-Mamoré. Other parts of the Amazon have contributed to it. The Xingu, Tapajos, and Tocantins may have played as important roles as the Guaporé.

The few unimportant genera that are peculiar to the Paraguay indicate that its fauna was received relatively recently. But sufficient time has elapsed for the derivation of 43 per cent of its species.

The Saõ Francisco and coastal streams may have contributed a few species to the Paraguay. This is indicated by the 35 species that are common to the Paraguay, the Saõ Francisco and the coastal streams; of these only 15 have been taken from the Amazon basin.

## Origin of the Fishes of the Paraguay

The close resemblance of the fishes of the Paraguay to the enormous and diversified fauna of the Amazon indicates their origin from the Amazonian forms. Furthermore, the nature of the divide between the two basins indicates that the fishes of the Amazon basin have had access to the Paraguay basin.

Haseman ('12), however, considered the precipitous falls in the rivers leaving the plateau of Matto Grosso to have been effective barriers to fish migration since the early Mesozoic epoch, except for certain generalized highland genera. This was before the present forms had evolved. Therefore, he was unable to explain the similarity of the Paraguayan fauna to that of the Amazon by migration. He explained the similarity of the Paraguayan fauna to that of the Amazonian by the hypothesis of "similar evolution in unconnected but similar environments" from a primitive and generalized highland stock which was present before the present configuration of the vast Amazonian region was attained. When the primitive and generalized forms reached the Paraguayan and Amazonian systems they were supposed to have undergone parallel evolution.

The geological history of the highlands of Matto Grosso and the Amazon basin, and the place of origin of the South American freshwater fish fauna indicate the Paraguayan fauna has reached that place only by migration through the Amazon valley and over the divide between the Amazon and the La Plata basins.

The highlands of Matto Grosso, where the headwaters of the Paraguay and the southern affluents of the Amazon take their origin, are Permian or older (Branner '19). Therefore some of the rivers which leave these highlands have flowed northward toward what is now the Amazon basin long before freshwater fishes were present in South America, probably before Cretaceous times.

The freshwater deposits of the late Tertiary period, which have been found along that part of the Amazon receiving the Madeira and Tapajos rivers, indicate a very low valley at that time. Agassiz ('68) considered the region between the highlands of Guiana and Brazil to have been below the sea before the Tertiary rise of the Andes. Haseman ('12) thought the Amazon basin had been above the sea since Permian times, and contained a westward flowing river until the Tertiary uplift of the Andes forced the water eastward. In either case it is rather certain that the Amazon basin was below sea level or very low during the latter part of the Mesozoic era. This was earlier than the establishment of any of the now existent genera of freshwater fishes.

The freshwater fish fauna of South America seems to have been derived from the north. Eigenmann ('09) stated that the distribution of the characinids and cichlids lent support to the Archhelenis theory. This theory gave the forms an origin from the hypothetical land bridge between Africa and South America, and has gained but little support among ichthyologists, who regard the similarity of the South American and African faunae as more superficial than real. Haseman ('12) gave the South American fish fauna a North American origin during the Miocene period. Evidence for this was based on *Priscacara*, a genus of fossil cichlids of doubtful relationship, which had been taken from Green River and Bridger Eocene of Wyoming and Utah. Nichols and Griscom ('17) considered the origin of the cichlids as probably marine during the Tertiary, and Nichols ('30) gave a northern origin to the catfishes and characinids.

Osborn ('10) considered the general South American fauna as having been derived from North America.

Fossil characinids belonging to the genera *Lignobrycon* and *Eobrycon*, which agree most closely with *Brycon*, *Henochilus*, and *Salminus*, have been found in the Tertiary deposits near Saõ Paulo, Brazil, and a third fossil genus has been described from scales taken from the Tertiary deposits at Huacho, Peru. Probably no genera of characinids which exist now were present until after the beginning of the Tertiary period, when the freshwater fishes probably entered the Amazon basin. At the time they entered, the Amazon basin was being formed, and the fishes before reaching the Paraguay had to pass through the developing Amazon basin. Here adaptive radiation began in every conceivable direction. Before the entrance of the fishes the Tocantins, Tapajos, Xingu, and Madeira or similar streams flowed toward the Amazon, and their tributaries were cutting back into the ancient highlands of Brazil. These highlands were the divide between the La Plata and the Amazon basins long before the fishes entered South America. Therefore the fishes have never had anything but a highland route over which to enter the Paraguay. If it is true that the highlands are a complete barrier at the present time as Dr. Haseman attempted to show and the character of the fishes of the two slopes may indicate, then there must have been a time when the slopes were less precipitous. This, in fact, must have been the condition before the southern tributaries of the Amazon had cut back into the older and harder formations where waterfalls of considerable height now exist. In order to account for the similarity of the Paraguayan fauna to that of the Amazon under this condition it becomes necessary to assume that the barriers did not appear until the genera and species common to the two basins had evolved.

The altitude of the streams on the highlands of Matto Grosso would not prevent the migration of lowland forms from the Amazonian system to the Paraguayan, because several collections from the eastern slopes of the Andes demonstrate that the lowland forms ascend those streams to an altitude of about 2500 feet.

In order to test whether the highlands had been a partial barrier the author attempted to analyze the physical effects of the divide by separating the fishes found in the Beni-Mamoré into strong and weak forms, based upon his South American collecting experience. These were then separated into those that had succeeded in getting across the divide and those that had not. The results showed that the weak forms were equally successful in crossing over. In like manner it was found that the Paraguay contained weak and strong swimming forms in equal proportion.

It is not known at present which tributaries of the Amazon offered the migratory path. Probably all that have headwaters near those of either the Paraguay or Parana have taken part. The large collection of fishes taken by Carlo Ternetz from the Rio Tocantins may throw some additional light on the question of the time and manner in which the entire La Plata received its fishes.

## Summary

The origin of the Paraguayan freshwater fish fauna can be explained by migration. It is not necessary to assume parallel evolution to account for the resemblance of the fauna of the Paraguay to that of the Amazon.

The fishes entered South America sometime during the Tertiary and crossed the low Amazon valley and a highland divide to enter the Paraguay. Other tributaries of the Amazon in addition to the Rio Guaporé seem to have been migratory paths.

The falls in the streams flowing from the highlands of Matto Grosso seem to be barriers to free migration at the present time; but the nature of the fishes of the two slopes indicate that the barrier is of recent origin.

## Symbols used in Distributional Lists

— in the first column indicates that the species is present in the Beni basin; | , that it is present in the Mamoré basin; + indicates that it is present in both basins.
— in the second column indicates that the species is present in the Paraguay basin.
* species peculiar to the Paraguay basin.
** genus and species peculiar to the Paraguay basin.
‡ species peculiar to the Mamoré basin.
‡‡ genus and species peculiar to the Mamoré basin.
† species peculiar to the Beni.
†† genus and species peculiar to the Beni.
a species found in the Amazon basin without the Beni-Mamoré basin.
A genus found in the Amazon basin.
c species found in the coastal streams of southeastern Brazil.
g species found in Guiana.
m species found in the Magdalena basin.
p species found in the La Plata basin but has not been taken in the Paraguay.
P genus found in the La Plata but has not been taken in the Paraguay.
s species found in the Saõ Francisco.
t species found in the Tocantins.
W species widespread, i. e., in northwestern South America, Amazon basin, Paraguay, and coastal streams of southeastern Brazil.

## Distribution of Fishes in the Paraguay and the Beni-Mamoré Systems

| | Beni-Mamoré | Paraguay |
|---|---|---|
| **POTAMOTRYGONIDAE** | | |
| a *Potamotrygon hystrix* | | — |
| a " *dumerilii* | | — |
| **CLUPEIDAE** | | |
| a *Neosteus flavipinnis* | — | |
| **ENGRAULIDAE** | | |
| a *Anchovia olida* | | — |
| " *brevirostris* | — | |
| **SYNBRANCHIDAE** | | |
| W *Synbranchus marmoratus* | — | — |
| **CHARACINIDAE** | | |
| Cheirodontinae | | |
| *Aphyocharax dentatus* | — | — |
| " *anisitsi* | — | — |
| * " *rathbuni* | | — |
| * " *paraguayensis* | | — |
| a " *pusillus* | \| | |
| a " *alburnus* | + | |
| * " *ipacarayensis* | | — |
| * " *pappenheimi* | | — |
| *Prionobrama paraguayensis* | | — |
| a " *filigerus* | + | |
| a *Paragoniates alburnus* | — | |
| * *Megalamphodus megalopterus* | | — |
| † " *rogoaguae* | — | |
| ** *Mixobrycon ribeiroi* | | — |
| a *Parecbasis cyclolepis* | \| | |
| ‡ *Microschemobrycon guaporensis* | \| | |
| sa *Cheirodon piaba* | — | — |
| * " *microdon* | | — |
| ‡ " *madeirae* | \| | |
| a *Holoshethes pequira* | \| | — |
| *Odontostilbe paraguayensis* | — | — |
| " *microcephala* | | — |
| ** *Mimagoniates barberi* | | — |
| †† *Monotocheirodon pearsoni* | — | |
| †† *Prodontocharax melanotus* | — | |
| p *Probolodus heterostomus* | \| | |
| Tetragonopterinae | | |
| *Tetragonopterus argenteus* | + | — |
| a *Moenkhausia jamesi* | \| | |
| sa " *sanctae-filomenae* | + | — |
| a " *grandisquamis* | \| | |
| " *dichroura* | + | — |
| a " *intermedia* | + | — |
| a " *lepidura lepidura* | \| | |
| a " " *gracilima* | \| | |
| a " *collettii* | \| | |
| a " *copei* | \| | |
| a " *ceros* | \| | |
| a " *cotinho* | + | |
| a *Knodus moenkhausii* | | — |
| * " *chapadae* | | — |
| a " *breviceps* | + | |
| ‡ " *jacunda* | \| | |
| *Markiana nigripinnis* | — | — |
| a *Gymnocorymbus thayeri* | — | |
| " *ternetzi* | + | — |
| a *Thayeria obliquus* | \| | |
| * *Hemigrammus ulreyi* | | — |
| s " *marginatus* | \| | — |
| * " *tridens* | | — |
| a " *lunatus* | + | — |
| a " *unilineatus* | \| | |
| a " *ocellifer* | — | |
| a " *schmardae* | \| | |
| a *Hyphessobrycon serpae* | \| | — |
| g " *rosaceus* | \| | |
| ‡ " *hasemani* | \| | |
| " *callistus* | + | — |
| a " *agulha* | \| | |
| sa " *gracilis* | | — |
| " *santae* | | — |
| " *anisitsi* | | — |
| " *lutkeni* | | — |
| * " *maxillaris* | | — |
| a† *Bryconacidnus ellisi* | — | |
| † " *hemigrammus* | — | |
| * *Astyanax alleni* | | — |
| * " *pellegrini* | | — |
| a " *abramis* | — | — |
| W " *bimaculatus* | + | — |
| a " " *paraguayensis* | | — |
| " *lineatus* | — | — |
| * " *marionae* | | — |
| W " *fasciatus* | \| | — |
| a " *eigenmanniorum* | | — |
| ‡ " *guaporensis* | + | |
| a *Ctenobrycon hauxwellianus* | + | — |
| s *Psellogrammus kennedyi* | | — |
| *Astyanacinus moorii* | — | — |
| † " *multidens* | — | |
| A* *Deuterodon acanthogaster* | | — |
| a *Bryconamericus exodon* | | — |
| " *iheringii* | | — |
| a " *alfredae* | — | |
| s " *stramineus* | | — |
| † " *bolivianus* | — | |
| a *Acrobrycon ipanquianus* | — | |
| a *Hemibrycon huambonicus* | — | |
| † " *beni* | — | |
| ma *Creagrutus beni* | — | |
| †P *Piabina beni* | — | |
| ** *Piabarchus analis* | | — |
| sga *Creatochanes affinis* | \| | — |
| ‡ *Bryconops alburnoides* | \| | |
| *Phenacogaster beni* | + | |

<table>
<tr><th></th><th></th><th>Beni-Mamoré</th><th>Paraguay</th></tr>
<tr><td>**</td><td>Vesicatrus tegatus</td><td></td><td>—</td></tr>
<tr><td>**</td><td>Bertoniolus paraguayensis</td><td></td><td>—</td></tr>
<tr><td></td><td>BRYCONINAE</td><td></td><td></td></tr>
<tr><td>A*</td><td>Brycon microlepis</td><td></td><td>—</td></tr>
<tr><td>*</td><td>“ hilarii</td><td></td><td>—</td></tr>
<tr><td></td><td>CHALCININAE</td><td></td><td></td></tr>
<tr><td>*</td><td>Chalcinus paranensis</td><td></td><td>—</td></tr>
<tr><td>a</td><td>“ angulatus</td><td>—</td><td>—</td></tr>
<tr><td>a</td><td>“ “ curtus</td><td>—</td><td>—</td></tr>
<tr><td>a</td><td>“ albus</td><td>—</td><td></td></tr>
<tr><td>††</td><td>Clupeacharax anchoveoides</td><td>—</td><td></td></tr>
<tr><td></td><td>STETHAPRIONINAE</td><td></td><td></td></tr>
<tr><td>*</td><td>Ephippicharax orbicularis paraguayensis</td><td></td><td>—</td></tr>
<tr><td>Pa</td><td>Stethaprion crenatus</td><td>—</td><td></td></tr>
<tr><td>a</td><td>Brachychalcinus copei</td><td>—</td><td></td></tr>
<tr><td></td><td>“ retrospina</td><td></td><td>—</td></tr>
<tr><td></td><td>IGUANODECTINAE</td><td></td><td></td></tr>
<tr><td>A</td><td>Piabucus melanostomus</td><td></td><td>—</td></tr>
<tr><td></td><td>GLANDULOCAUDINAE</td><td></td><td></td></tr>
<tr><td></td><td>Pseudocorynopoma doriae</td><td></td><td>—</td></tr>
<tr><td>†</td><td>Gephyrocharax major</td><td>—</td><td></td></tr>
<tr><td></td><td>SERRASALMONINAE</td><td></td><td></td></tr>
<tr><td>a</td><td>Serrasalmus nattereri</td><td>|</td><td>— ?</td></tr>
<tr><td>*</td><td>“ ternetzi</td><td></td><td>—</td></tr>
<tr><td></td><td>“ marginatus</td><td></td><td>—</td></tr>
<tr><td>a</td><td>“ spilopleura</td><td>+</td><td>—</td></tr>
<tr><td>a</td><td>“ humeralis</td><td>+</td><td>—</td></tr>
<tr><td>‡</td><td>“ “ gracilior</td><td>|</td><td></td></tr>
<tr><td>‡</td><td>“ hollandi</td><td>|</td><td></td></tr>
<tr><td>a</td><td>“ elongatus</td><td>|</td><td></td></tr>
<tr><td>a</td><td>Colossoma brachypomus</td><td>|</td><td></td></tr>
<tr><td></td><td>“ mitrei</td><td></td><td>—</td></tr>
<tr><td>a</td><td>Mylossoma aureum</td><td>+</td><td></td></tr>
<tr><td>a</td><td>“ duriventris</td><td>+</td><td>—</td></tr>
<tr><td>*</td><td>“ paraguayensis</td><td></td><td>—</td></tr>
<tr><td>*</td><td>“ ocellatum</td><td></td><td>—</td></tr>
<tr><td>‡</td><td>Metynnis guaporensis</td><td>|</td><td></td></tr>
<tr><td>a</td><td>“ roosevelti</td><td>+</td><td></td></tr>
<tr><td>*</td><td>“ otuquensis</td><td></td><td>—</td></tr>
<tr><td>*</td><td>“ mola</td><td></td><td>—</td></tr>
<tr><td>a</td><td>“ maculatus</td><td>|</td><td>—</td></tr>
<tr><td>a</td><td>“ hypsauchen</td><td>|</td><td>—</td></tr>
<tr><td>a</td><td>Myleus setiger</td><td>|</td><td></td></tr>
<tr><td></td><td>Myloplus levis</td><td>|</td><td>—</td></tr>
<tr><td>a</td><td>“ rubripinnis</td><td></td><td>—</td></tr>
<tr><td>a</td><td>Catoprion mento</td><td>+</td><td></td></tr>
<tr><td></td><td>CYNODONTINAE</td><td></td><td></td></tr>
<tr><td>a</td><td>Cynodon gibbus</td><td>|</td><td></td></tr>
<tr><td>a</td><td>“ vulpinus</td><td></td><td>—</td></tr>
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<table>
<tr><th></th><th></th><th>Beni-Mamoré</th><th>Paraguay</th></tr>
<tr><td></td><td>CHARACINAE</td><td></td><td></td></tr>
<tr><td>a</td><td>Charax gibbosa</td><td>—</td><td>—</td></tr>
<tr><td></td><td>“ argentea</td><td></td><td>—</td></tr>
<tr><td></td><td>“ squamosus</td><td>—</td><td>—</td></tr>
<tr><td>*</td><td>“ caliurus</td><td></td><td>—</td></tr>
<tr><td>a</td><td>Roestes molossus</td><td></td><td>—</td></tr>
<tr><td>a</td><td>Roeboides microlepis</td><td>|</td><td>—</td></tr>
<tr><td>*</td><td>“ prognathus</td><td></td><td>—</td></tr>
<tr><td>a</td><td>“ affinis</td><td>—</td><td></td></tr>
<tr><td></td><td>“ bonariensis</td><td></td><td>—</td></tr>
<tr><td>*</td><td>“ descalvadensis</td><td></td><td>—</td></tr>
<tr><td>a</td><td>Eucynopotamus kneri</td><td>—</td><td>—</td></tr>
<tr><td>m</td><td>“ magdalenae</td><td>|</td><td>—</td></tr>
<tr><td>a</td><td>“ humeralis</td><td>|</td><td>—</td></tr>
<tr><td>c</td><td>Salminus maxillosus</td><td></td><td>—</td></tr>
<tr><td>a</td><td>“ hilarii</td><td>—</td><td>—</td></tr>
<tr><td></td><td>ACESTRORHAMPHINAE</td><td></td><td></td></tr>
<tr><td>a</td><td>Acestrorhynchus falcatus</td><td>+</td><td>—</td></tr>
<tr><td>Ac</td><td>Acestrorhamphus hepsetus</td><td></td><td>—</td></tr>
<tr><td></td><td>ERYTHRININAE</td><td></td><td></td></tr>
<tr><td>W</td><td>Hoplias malabaricus</td><td>—</td><td>—</td></tr>
<tr><td>W</td><td>Hoplerythrinus unitaeniatus</td><td>—</td><td>—</td></tr>
<tr><td>a</td><td>Erythrinus erythrinus</td><td>|</td><td></td></tr>
<tr><td></td><td>GASTEROPELECIDAE</td><td></td><td></td></tr>
<tr><td>a</td><td>Thoracocharax stellatus</td><td>—</td><td>—</td></tr>
<tr><td></td><td>ANOSTOMIDAE</td><td></td><td></td></tr>
<tr><td>P‡</td><td>Anostomus gracilis</td><td>|</td><td></td></tr>
<tr><td>a</td><td>“ proximus</td><td>|</td><td></td></tr>
<tr><td>a</td><td>Curimata spilurus</td><td>—</td><td>—</td></tr>
<tr><td>*</td><td>“ gillii</td><td></td><td>—</td></tr>
<tr><td>a</td><td>“ nasus</td><td>—</td><td>—</td></tr>
<tr><td>*</td><td>“ conspersus</td><td></td><td>—</td></tr>
<tr><td>*</td><td>“ nigrotaenia</td><td></td><td>—</td></tr>
<tr><td>c</td><td>“ elegans</td><td></td><td>—</td></tr>
<tr><td></td><td>“ “ nitens</td><td>—</td><td>—</td></tr>
<tr><td>a</td><td>“ bimaculatus</td><td>|</td><td>—</td></tr>
<tr><td>c</td><td>“ gilberti</td><td></td><td>—</td></tr>
<tr><td>a</td><td>“ rutiloides</td><td></td><td>—</td></tr>
<tr><td>†</td><td>“ binotatus</td><td>—</td><td></td></tr>
<tr><td>†</td><td>“ esperanzae</td><td>—</td><td></td></tr>
<tr><td>†</td><td>“ pearsoni</td><td>—</td><td></td></tr>
<tr><td>s</td><td>Prochilodus reticulatus</td><td>—</td><td>—</td></tr>
<tr><td>a</td><td>“ nigricans</td><td>—</td><td>—</td></tr>
<tr><td>s</td><td>“ argenteus</td><td></td><td>—</td></tr>
<tr><td>c</td><td>“ scrofa</td><td></td><td>—</td></tr>
<tr><td></td><td>“ lineatus</td><td></td><td>—</td></tr>
<tr><td>†</td><td>“ beni</td><td>—</td><td></td></tr>
<tr><td>a</td><td>Anodus latior</td><td>|</td><td>—</td></tr>
<tr><td>a</td><td>“ laticeps</td><td>|</td><td>—</td></tr>
<tr><td>a</td><td>Leporinus striatus</td><td>—</td><td>—</td></tr>
<tr><td>a</td><td>“ frederici</td><td>—</td><td>—</td></tr>
<tr><td>a</td><td>“ obtusidens</td><td></td><td>—</td></tr>
<tr><td>a</td><td>“ trifasciatus</td><td></td><td>—</td></tr>
<tr><td>a</td><td>“ eques</td><td></td><td>—</td></tr>
<tr><td>a</td><td>“ affinis</td><td></td><td>—</td></tr>
</table>

| | | Beni-Mamoré | Paraguay |
|---|---|---|---|
| a | *Leporinus hypselonotus* | | — |
| ca | " *conirostris* | | — |
| a | " *fasciatus* | — | — |
| a | " *y-ophorus* | — | |
| a | " *maculatus* | | — |
| a | *Rhytiodus microlepis* | — | |
| † | *Laemolyta fasciata* | — | |
| a | *Psectrogaster curviventris* | | — |
| a | " *ciliatus* | \| | — |
| a | *Curimatella alburnus* | \| | — |
| * | " " *australis* | | — |
| * | " *rehni* | | — |
| a | *Schizodon fasciatus* | | — |
| * | " *borelli* | | — |
| a | " *dissimilis* | — | — |
| s | " *isognathus* | | — |
| a | *Lahilliella nasutus* | | — |
| | HEMIODONTIDAE | | |
| a | *Parodon suborbitalis* | — | — |
| s | " *tortuosus* | | — |
| * | " *gestri* | | — |
| s | " *hilarii* | — | — |
| | *Apareiodon affinis* | | — |
| a | *Hemiodus unimaculatus* | | — |
| a | " *semitaeniatus* | \| | — |
| a | " *microlepis* | | — |
| * | *Anisitsia othonops* | | — |
| sa | " *notata* | \| | |
| A | *Nannostomus stigmasemion* | \| | |
| ca | *Characidium fasciatum* | — | — |
| * | " *lateralis* | | — |
| † | " *bolivianum* | — | |
| a | *Pyrrhulina australis* | | — |
| † | " *beni* | — | |
| | RHAMPHICHTHYIDAE | | |
| a | *Rhamphichthys rostratus* | | — |
| W | *Hypopomus brevirostris* | — | — |
| a | " *artedi* | \| | — |
| p | *Gymnorhamphichthys hypostomus* | \| | |
| | APTERONOTIDAE | | |
| a | *Sternarchus albifrons* | | — |
| a | *Odontosternarchus sachsi* | \| | |
| | GYMNOTIDAE | | |
| W | *Gymnotus carapo* | — | — |
| W | *Sternopygus macrurus* | — | — |
| W | *Eigenmannia virescens* | — | — |
| a | " *troscheli* | \| | |
| | ELECTROPHORIDAE | | |
| a | *Electrophorus electricus* | \| | |

| | | Beni-Mamoré | Paraguay |
|---|---|---|---|
| | AUCHENIPTERIDAE | | |
| a | *Trachelyopterus coriaceus* | — | — |
| a | *Centromochlus heckelii* | \| | |
| a | " *intermedius* | \| | |
| a | " *aulopygius* | \| | |
| a | *Trachycorystes ceratophysus* | + | |
| sa | " *galeatus* | + | — |
| ca | " *striatulus* | | — |
| a | *Auchenipterichthys thoracatus* | \| | |
| a | *Auchenipterus nuchalis* | — | |
| * | " *nigripinnis* | | — |
| ‡ | *Tetranematichthys quadrifilis* | \| | |
| | *Entomocorus benjamini* | \| | — |
| | DORADIDAE | | |
| a | *Pterodoras granulosus* | \| | — |
| as | *Platydoras costatus* | + | — |
| a | *Acanthodoras cataphractus* | \| | |
| a | " *spinosissimus* | \| | |
| a | *Amblydoras hancocki* | + | |
| a | *Anadoras weddellii* | \| | — |
| * | *Oxydoras kneri* | | — |
| a | *Trachydoras nattereri* | \| | |
| a | " *paraguayensis* | \| | — |
| a | " *atripes* | \| | |
| a | *Doras punctatus* | \| | |
| a | " *eigenmanni* | | — |
| a | *Opsodoras humeralis* | \| | |
| a | *Astrodoras asterifrons* | \| | |
| a | *Leptodoras linnelli* | \| | |
| * | *Rhinodoras d'Orbignyi* | | — |
| | AGENEIOSIDAE | | |
| m | *Ageneiosus dentatus* | \| | |
| a | " *brevifilis* | \| | — |
| ‡ | " *madeirensis* | \| | |
| a | " *valenciennesi* | | — |
| | HYPOPHTHALMIDAE | | |
| a | *Hypophthalmus edentatus* | | — |
| | PIMELODIDAE | | |
| a | *Callophysus macropterus* | \| | |
| c | *Pimelodella serrata* | \| | |
| a | " *cristata* | \| | |
| a | " *gracilis* | + | — |
| | " *mucosa* | \| | — |
| a | " *roccae* | — | |
| a | " *buckleyi* | — | |
| | " *griffini* | — | — |
| * | " *laticeps* | | — |
| | " " *australis* | — | — |
| * | " *notomelas* | | — |
| | " *meeki* | | — |
| * | " *megalura* | | — |
| a | *Pinirampus pirinampu* | | — |
| a | *Luciopimelodus platanus* | | — |

| | | Beni-Mamoré | Paraguay |
|---|---|---|---|
| W | *Pseudopimelodus zungaro* | — | — |
| * | " *coltoides* | | — |
| a | " *acanthocheira* | \| | |
| * | " *variolosus* | | — |
| W | *Rhamdia sebae* | \| | — |
| a | " " *kneri* | | — |
| a | " *micayi* | — | |
| W | " *quelen* | + | — |
| † | *Nannorhamdia guttatus* | — | |
| †P | *Imparfinis bolivianus* | — | |
| †P | *Rhamdella rusbyi* | — | |
| a | *Pimelodus ornatus* | | — |
| | " *albicans* | | — |
| W | " *clarias* | + | — |
| S | " *valenciennis* | | — |
| a | " *altipinnis* | \| | |
| a | *Platynematichthys punctulatus* | \| | |
| A* | *Nannoglanis hoehnei* | | — |
| a | *Phractocephalus hemilioplerus* | \| | |
| a | *Sciades pictus* | | — ? |
| a | *Hemisorubim platyrhynchus* | \| | — |
| Asa | *Pseudoplatystoma coruscans* | | — |
| ma | " *fasciatum* | | — |
| W | *Sorubim lima* | + | — |
| a | *Sorubimichthys planiceps* | \| | |
| | *Iheringichthys labrosus* | | — |
| * | " *megalops* | | — |
| †† | *Pteroglanis manni* | — | |
| m | *Cetopsorhamdia nasus* | — | |
| a | *Platysilurus barbatus* | \| | |
| a | *Cheirocerus eques* | \| | |
| a | *Heptapterus mustelinus* | | — |
| | **BUNOCEPHALIDAE** | | |
| * | *Bunocephalus doriae* | | — |
| | " *iheringii* | | — |
| * | " *rugosus* | | — |
| ‡ | " *depressus* | \| | |
| † | " *bifidus* | — | |
| | **ASPREDINIDAE** | | |
| A* | *Dysichthys australe* | | — |
| | **PYGIDIIDAE** | | |
| † | *Pygidium barbouri* | — | |
| † | " *fassli* | — | |
| a | " *hasemani* | \| | |
| a | " *rivulatum* | + | |
| | " *eichorniarum* | — | — |
| a | " *borellii* | | — |
| | " *corduvense* | | — |
| sa | " *brasiliense* | | — |
| * | " *johnsoni* | | — |
| * | *Homodiaetus anisitsi* | | — |
| A* | *Ochmacanthus batrachostoma* | | — |
| ** | *Paravandellia oxyptera* | | — |

| | | Beni-Mamoré | Paraguay |
|---|---|---|---|
| ** | *Branchioica bertonii* | | — |
| a | *Urinophilus erythrurus* | — | |
| ‡ | *Vandellia hasemani* | \| | |
| †† | *Tridentopsis pearsoni* | — | |
| a | *Pseudostegophilus nemurus* | \| | |
| | **CETOPSIDAE** | | |
| Pa | *Cetopsis candiru* | — | |
| a | " *plumbeus* | — | |
| | **ASTROBLEPIDAE** | | |
| † | *Astroblepus longiceps* | — | |
| | **CALLICHTHYIDAE** | | |
| W | *Callichthys callichthys* | + | — |
| W | *Hoplosternum thoracatum* | + | — |
| W | " *littorale* | — | — |
| a | " *melampterum* | | — |
| A* | *Chaenothorax eigenmanni* | | — |
| s | *Corydoras nattereri* | \| | |
| | " *microps* | \| | — |
| | " *virescens* | \| | — |
| a | " *armatus* | \| | |
| | " *australis* | \| | — |
| | " *aeneus* | — | — |
| | " *flaveolus* | | — |
| * | " *aurofrenatus* | | — |
| * | " *polystictus* | | — |
| * | " *paleatus* | | — |
| † | " *latus* | — | |
| | **LORICARIIDAE** | | |
| | PLECOSTOMINAE | | |
| a | *Plecostomus plecostomus* | — | — |
| s | " *macrops* | | — |
| s | " *commersonii* | | — |
| s | " *vaillanti* | | — |
| * | " *ternetzi* | | — |
| ca | " *robinii* | | — |
| cs | " *wuchereri* | | — |
| c | " *auroguttatus* | | — |
| * | " *borellii* | | — |
| a | " *latirostris* | \| | — |
| * | " *variostictus* | | — |
| a | " *verres* | \| | |
| a | " *emarginatus* | — | |
| † | " *popoi* | — | |
| † | " *bolivianus* | — | |
| † | *Ancistrus montanus* | — | |
| a | " *bufonius* | — | |
| a | " *cirrhosus* | — | — |
| a | " " *dubius* | | — |
| a | " *hoplogenys* | — | — |
| † | " *megalostomus* | — | |
| †P | *Rhinelepis levis* | — | |
| a | *Hemiancistrus vittatus* | | — |
| a | *Pseudancistrus barbatus* | | — |
| a | *Xenocara gymnorhynchus* | | — |

| | Beni-Mamoré | Paraguay |
|---|---|---|
| a *Pterygoplichthys multiradiatus* | — | — |
| * " *anisitsi* | | — |
| * " *juvens* | | — |
| * " *gigas* | | — |
| a " *lituratus* | │ | |
| a *Cochliodon cochliodon* | | — |
| HYPOPTOPOMATINAE | | |
| a *Hypoptopoma joberti* | — | |
| * " *inexpectatum* | | — |
| a *Otocinclus vittatus* | | — |
| LORICARIINAE | | |
| * *Loricaria parva* | | — |
| a " *phoxocephala* | | — |
| " *catamarcensis* | | — |
| a " *maculata* | │ | — |
| a " *typus* | — | — |
| a " *lanceolata* | — | |
| c " *anus* | | — |
| " *labialis* | | — |
| a " *cataphracta* | │ | — |
| a " *carinata* | — | — |
| * " *apeltogaster* | | — |
| " *laticeps* | | — |
| * " *macrodon* | | — |
| * " *platycephala* | | — |
| * " *hoehnei* | | — |
| c " *nigricauda* | | — |
| * " *cacerensis* | | — |
| † " *beni* | — | |
| a *Homiodontichthys acipenserinus* | │ | — |
| a *Farlowella oxyrhynchus* | │ | — |
| a " *kneri* | | — |
| * " *jauruensis* | | — |
| † " *acestrichthys* | — | |
| A* *Sturisoma robustum* | | — |
| a " *barbatum* | | — |
| a " *rostrata* | | — |
| CYPRINODONTIDAE | | |
| *Rivulus balzanii* | │ | — |
| a " *punctatus* | │ | — |
| † " *beniensis beniensis* | — | |
| † " " *lacustris* | — | |
| † " *rogoaguae* | — | |
| ** *Neofundulus paraguayensis* | | — |
| ** *Rivulichthys rondoni* | | — |
| POECILIIDAE | | |
| *Cnesterodon decemmaculatus* | | — |
| c *Phalloceros caudimaculatus* | | — |
| * *Pamphorichthys hasemani* | | — |
| ca *Poecilia vivipara* | | — |
| c *Jenynsia lineata* | | — |
| BELONIDAE | | |
| a *Tylosurus amazonicus* | | — |
| a *Potamorrhaphis guianensis* | — | — |

| | Beni-Mamoré | Paraguay |
|---|---|---|
| ACHIRIDAE | | |
| a *Achirus lineatus* | | — |
| " *jenynsii* | | — |
| SCIAENIDAE | | |
| * *Plagioscion ternetzi* | | — |
| a " *auratus* | — | |
| *Pachyurus bonariensis* | | — |
| a " *schomburgkii* | | — |
| *Pachypops trifilis* | │ | |
| CICHLIDAE | | |
| A* *Chaetobranchopsis australis* | | — |
| a *Chaetobranchus flavescens* | — | |
| a *Cichla ocellaris* | + | |
| a *Acaropsis nassa* | + | |
| a *Astronotus ocellatus* | + | — |
| a *Aequidens tetramerus* | + | — |
| c " *portalegrensis* | + | — |
| a " *vittatus* | | — |
| a " *dorsigera* | + | — |
| " *paraguayensis* | │ | — |
| ‡ " *guaporensis* | │ | |
| ‡ " *awani* | │ | |
| a *Cichla bimaculatum* | | — |
| a " *severum* | + | |
| a *Mesonauta festivum* | + | — |
| *Crenicara maculata* | │ | — |
| ‡ " *altispinosa* | │ | |
| A* *Batrachops ocellatus* | | — |
| " *semifasciatus* | | — |
| a *Crenicichla lepidota* | + | — |
| " *simoni* | — | — |
| a " *saxatilis* | — | — |
| a " *cyanota* | │ | |
| a " *reticulata* | + | |
| a " *macrophthalma* | + | |
| a " *lugubris* | │ | |
| a " *lenticulata* | │ | |
| a " *johanni* | │ | |
| a " *vittata* | | — |
| *Apistogramma trifasciatum* | │ | |
| * " *corumbae* | | — |
| * " *borellii* | | — |
| * " *ritensi* | | — |
| a " *agassizi* | │ | |
| a " *ortmanni* | │ | |
| a " *taeniatum* | + | — |
| a " " *pertense* | — | |
| ‡ " *trifasciatum maciliensi* | │ | |
| a *Geophagus surinamensis* | │ | |
| a " *cupido* | + | |
| a " *jurupari* | + | — |
| * " *balzani* | | — |
| c " *braziliensis* | | — |
| A *Nannacara hoehnei* | | — |

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## No. 9

# MAMMALS OF DEATH VALLEY[1]

BY

JOSEPH GRINNELL
*Museum of Vertebrate Zoology*
*University of California*

The present account pertains exclusively to that portion of Death Valley, Inyo County, California, which lies below sea-level. The boundary thus arbitrarily set is the topographic contour marked "00" on the Ballarat and Furnace Creek sheets, United States Geological Survey. No species is listed in this paper that has not been found in the mapped area surrounded by this contour. The lowest point in this area as shown on the maps cited, at the sink marked "Bad Water," has been variously given as 280 to 310 feet below sea-level.

The materials upon which this contribution is chiefly based are contained in the Museum of Vertebrate Zoology and were gathered during three trips made into Death Valley. In 1917, on April 2, in company of Mr. Joseph Dixon, then also of the Museum staff, I entered the Valley by the way of the road down Furnace Creek Wash, and I left on May 2 by the way of Ryan; Mr. Dixon remained, and at intervals he collected mammals in below-sea-level parts of the Valley, until May 22, when he left by the road up Emigrant Cañon. In 1920, in company of Dr. Francis B. Sumner, of the (then) Scripps Institution of Biological Research, I came into the Valley

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down the Emigrant Cañon road on April 2 and left by the Furnace Creek Wash road on April 22. In 1933, in company of Mrs. Hilda W. Grinnell, I entered the Valley over the (then) Eichbaum Toll Road on October 13 and left over the highway to Death Valley Junction on October 30.

During each of these three trips specimens of vertebrate animals were collected, and field notes gathered, by my companions as well as myself. The vigorous cooperation of each one of them is hereby acknowledged, and specific instances of help are mentioned in the course of the following accounts. Headquarters on each trip were made at Furnace Creek Ranch, but numerous collecting stations were occupied up and down the Valley, though some of them were merely one-night "dry" camps. Localities have been described and some peculiarities of the natural history of the area discussed in my preceding papers on the birds: "Observations upon the Bird Life of Death Valley" (Proc. Calif. Acad. Sci., ser. 4, vol. 13, 1923, pp. 43-109); "Further Observations upon the Bird Life of Death Valley" (Condor, vol. 36, 1934, pp. 67-72). Place-names are employed throughout the present account of the mammals as used in my other papers, which are as shown on the old U.S.G.S. topographic sheets. No attempt is made to concord with the new place-names on various later maps, resultant from the current great human "development" of the Valley.

I have made no effort to incorporate in this report facts from outside sources. The Death Valley Expedition of 1891, under the leadership of Dr. C. Hart Merriam, traversed the general region; while mammals were collected at places on the floor of the Valley, no single report on them, as originally was planned, has ever appeared. The specimens obtained, most of them probably, have been recorded here and there, in connection with general systematic revisions of single species or genera. Edmund Heller collected in the Valley briefly in 1903, and his mammals were reported upon by Elliot (Field Columb. Mus., zool. ser., vol. 3, no. 16, 1904). Other collectors have visited Death Valley, but no species other than those listed herein, has to my knowledge been found.

The collection of mammals in the Museum of Vertebrate Zoology from the restricted portion of Death Valley under consideration numbers 305 specimens. These represent 25 out of the 26 species known to date from that area—all of them except *Homo*. The total list follows.

[Since this paper was written, Miss Annie M. Alexander and Miss Louise Kellogg did some field work in Death Valley, chiefly in search of the elusive pocket mouse, *Perognathus penicillatus stephensi*. In this quest they were successful, and I am permitted to include an account of their findings herein, under the appropriate species heading.]

MAMMALS KNOWN FROM BELOW-SEA-LEVEL PORTION OF DEATH VALLEY

*Myotis californicus pallidus* Stephens. Desert Little California Bat.
*Lasionycteris noctivagans* (LeConte). Silvery-haired Bat.
*Pipistrellus hesperus hesperus* (H. Allen). Western Canyon Bat.
*Nycteris cinerea* (Peale and Beauvois). Hoary Bat.
*Antrozous pallidus pallidus* (LeConte). Desert Pallid Bat.
*Tadarida mexicana* (Saussure). Mexican Free-tailed Bat.
*Taxidea taxus berlandieri* Baird. Mexican Badger.
*Vulpes macrotis arsipus* Elliot. Desert Kit Fox.
*Canis latrans estor* Merriam. Desert Coyote.
*Lynx rufus baileyi* Merriam. Desert Wildcat.
*Homo sapiens americanus* Linnaeus. American Indian.
*Citellus tereticaudus eremonomus* Elliot. Death Valley Round-tailed Ground Squirrel.
*Ammospermophilus leucurus leucurus* Merriam. Desert Antelope Ground Squirrel.
*Perognathus formosus formosus* Merriam. Utah Long-tailed Pocket Mouse.
*Perognathus penicillatus stephensi* Merriam. Stephens Desert Pocket Mouse.
*Dipodomys merriami merriami* Mearns. Merriam Kangaroo Rat.
*Dipodomys deserti deserti* Stephens. Big Desert Kangaroo Rat.
*Onychomys torridus longicaudus* Merriam. Long-tailed Grasshopper Mouse.
*Reithrodontomys megalotis megalotis* (Baird). Desert Harvest Mouse.
*Peromyscus crinitus stephensi* Mearns. Stephens Canyon Mouse.
*Peromyscus eremicus eremicus* (Baird). Desert White-footed Mouse.
*Peromyscus maniculatus sonoriensis* (LeConte). Sonora White-footed Mouse.
*Neotoma lepida lepida* Thomas. Desert Wood Rat.
*Lepus californicus deserticola* Mearns. Desert Jack Rabbit.
*Sylvilagus audubonii arizonae* (Allen). Arizona Cottontail.
*Ovis canadensis nelsoni* Merriam. Desert Bighorn.

I have collated from the collectors' notebooks, and present herewith, the records of rodent traps out and the "catch" for the five general localities worked in the below-sea-level portion of Death Valley. The resulting figures do not include those of Dr. Sumner at Furnace Creek Ranch; these are given in toto in a table elsewhere in this paper. Also, in 1917, there were rodents captured and saved as specimens, from trap-lines, record of which was, unfortunately, not kept. It should further be understood that nowhere nearly all mammals caught were saved as specimens; there were "discards", but these are included in the records of catch which enter into the figures now given.

A total of 2445 trap-nights definitely of record produced exactly 300 rodents, of 12 species. This means 8+ trap-nights per rodent caught, on all sorts of ground, or a 12+ per cent "catch." I tried to tabulate this catch by habitats, but the record is not satisfactory for determining traps-out per habitat. Of the rodents caught (300), 217 are definitely recorded as taken under or near mesquites (on sand dunes, sandy ground, or silty ground). This substantiates the general impression gained that the mesquite growths are productive of the greatest amount of animal life. Still, here, the data per se are not to be given full reliance, for trapping was undoubtedly done most extensively and intensively in and around mesquites for the reason that series of topotypes of mammals named from Death Valley were, from a systematic point of view, greatly desired and these (*Citellus*, *Perognathus penicillatus*, *Dipodomys* and *Neotoma*) are inhabitants, chiefly at least, of the areas where mesquites grow.

My field work in Death Valley, the character of which has been indicated in preceding paragraphs, has led me to designate eleven mammalian habitats there, each occupied by a separate plant-animal association. The main factors determining these habitat dependencies are: Kind and continuity of food available, appropriate to each species; nature of accessible cover, especially as providing protection from sunshine, varying with the structural peculiarities of each species; and soil-texture, varyingly important in accordance with the digging abilities of the animals concerned, to secure sufficiently safe breeding and resting places, and escape from sunshine.

Curiously, even on this driest of dry deserts, few mammals seem to have any need of free water. I found no evidence that any rodent or lagomorph visits water, even when accessible. It is probable that bats and carnivores require water, at least occasionally. Tracks of *Canis* and *Vulpes* were seen at springs or wells regularly enough to indicate water as the objective of these animals. Only *Homo* and *Ovis* appear to be water-dependent. The water factor, therefore, does not figure directly as an important habitat component for the general mammal fauna of this region. Free water is doubtless obtained *in*directly by some mammals, such as lagomorphs and probably certain cricetids, which feed on green vegetation. (For an illuminating discussion of this and other factors in the problem of desert existence, see Sumner, Ecology, vol. 6, 1925, pp. 352 ff).

Vegetation is, of course, the fundamental food source, here as elsewhere; and the several sharply marked off plant formations in Death Valley provide separate kinds of food, accessible to mammals in different ways, so as to contribute to the habitat restriction observable severally among the different species. Also, vegetation figures similarly with respect to its service varyingly to many different kinds of mammals as cover, securing for them protection from sun and safety from enemies. However, rocks, and soil (to fossorial kinds), serve also in this way.

The mammalian habitats in Death Valley thus can be distinguished, and briefly defined in the terms chosen, as follows. In the discussions of species this terminology is followed.

[Borax flat — abiotic ?]
Ink-weed (*Allenrolfea*, on strongly alkaline ground)
Tule (or cane—along streams, or at springs or seepages)
Salt-grass (on alkaline ground)
Arrow-weed (on silty or clayey ground)
Cultivated ranch-land
In or near buildings [edificarian]
Mesquite (on either silty or sandy ground)
Aeolian sand (sand-dune)
Creosote bush (on either sandy or gravelly ground)
Desert holly (wash-fan)
Rocky gorge (cliff)

On the evening of April 18, 1917, a line of 86 traps (26 rat traps and 60 mouse traps) was put out on the low-lying desert one to two miles north of Furnace Creek Ranch. These were set on three types of ground: (*a*) sandy, beneath creosote bushes, 9 mouse traps; (*b*) sandy, beneath mesquite thicket, 25 rat traps and 31 mouse traps; (*c*) clayey, beneath arrow-weed clumps, 1 rat trap and 20 mouse traps. This line, set with proper spacing of traps and regard for "sign", thus cut through three distinct habitats. It was run five consecutive nights and days, with no change in locations of traps, save that involved in re-setting and re-baiting. Results are shown in the following table.

| | *Citellus tereticaudus* | *Ammospermophilus leucurus* | *Perognathus formosus* | *Dipodomys merriami* | *Dipodomys deserti* | *Onychomys torridus* | *Peromyscus eremicus* | *Neotoma lepida* | Total rodents |
|---|---|---|---|---|---|---|---|---|---|
| Apr. 19.. | ...... | ...... | 3 in *a*<br>1 in *b* | 13 in *b*<br>3 in *c* | 1 in *b* | ...... | 2 in *b*<br>1 in *c* | 1 in *b* | 25 |
| Apr. 20.. | ...... | ...... | 2 in *b* | 1 in *a*<br>2 in *b*<br>2 in *c* | ...... | 1 in *b* | ........ | 6 in *b* | 14 |
| Apr. 21.. | ...... | 1 in *c* | 1 in *a*<br>1 in *b*<br>2 in *c* | 1 in *a*<br>5 in *b*<br>4 in *c* | 3 in *b*<br>1 in *c* | 1 in *b* | 2 in *b*<br>4 in *c* | 1 in *b* | 27 |
| Apr. 22.. | ...... | ...... | 2 in *b* | 1 in *b*<br>2 in *c* | 1 in *c* | ...... | 1 in *b*<br>1 in *c* | 3 in *b* | 11 |
| Apr. 23.. | 1 in *b* | ...... | ........ | 2 in *b* | 1 in *b* | ...... | 1 in *b*<br>3 in *c* | ...... | 8 |
| Habitat Totals | 1 in *b* | 1 in *c* | 4 in *a*<br>6 in *b*<br>2 in *c* | 2 in *a*<br>23 in *b*<br>11 in *c* | 5 in *b*<br>2 in *c* | 2 in *b* | 6 in *b*<br>9 in *c* | 11 in *b* | 6 in *a*<br>54 in *b*<br>25 in *c* |
| Grand Totals | 1 | 1 | 12 | 36 | 7 | 2 | 15 | 11 | 85 |

This is the most extended and complete trap-record for a single station that the Death Valley notebooks contain. A total of 430 trap-nights on one line brought a catch of 85, which is approximately a 20 per cent yield. Eight species of rodents were represented. Only two of these, *Citellus* and *Ammospermophilus*, are diurnal in habits, and only two individuals, or 2⅓ per cent of the total catch, were of these species; all the rest are strictly nocturnal.

As to habitat preference, the sandy mesquite produced most kinds (7 out of the 8 species), the sandy creosote fewest kinds (2 out of the 8). The trap-habitat figures (9–56–21), however, as compared with the catch-habitat figures (6–54–25) show a slightly greater incidence of individuals in the clayey arrow-weed habitat, but again least in the sandy creosote. There are factors appreciable here, however, that prevent reliance upon these sparse figures for purposes of generalization.

As to population numbers the percentage yield in this instance was large, up to the average maximum for almost any area in California, desert or otherwise. However, this trap-line was on extra productive terrain, as clearly shown by the trap-records, even though less complete, from other parts of Death Valley. Nothing can, of course, be inferred as to actual population numbers per unit of area. Nor can relative abundance of the species be very definitely inferred beyond the one case, of *Dipodomys merriami*, which is obviously the most numerous rodent on this part of the desert. Difficulties in accepting these figures in this regard have to do with kinds of traps used, kinds of bait used, and cruising radius (unknown) of each kind of mammal present.

Dr. Sumner's trapping was all done with the "Delusion" brand of "live" trap. This has the advantage that several mice may be taken in a single night without any re-setting. A disadvantage, however, is that rodents any larger than a *Peromyscus* tend to be excluded. A total of 773 trap-nights produced 356 mice. Of these, 168 were *Peromyscus m. sonoriensis*, 165 *Peromyscus e. eremicus*, 12 *Reithrodontomys m. megalotis*, 9 *Perognathus f. formosus*, and 2 *Onychomys t. longicaudus*. Also one very young *Neotoma l. lepida* was caught and one *Dipodomys m. merriami*. The captures of these larger species were, of course, without significance in the present connection.

It should be emphasized that it was the two species of *Peromyscus* that Dr. Sumner especially wanted, for use in connection with his genetics problem. His growing experience in trapping was used to good effect in guiding his later efforts accordingly. The other species were by-products. Even so, there is indicated something of decided significance as to habitat preferences.

I have checked Dr. Sumner's notebook records of captures, April 5 to 14, inclusive, 1920, with results of some further interest. Certain minor variation in totals will be observed, due to the circumstance that occasionally the age of an animal was recorded, when its sex was for some reason not ascertained; also in a few cases habitat was recorded for a given capture when age and (or) sex was not, or vice versa.

Of 168 *Peromyscus m. sonoriensis* concerning which age was definitely recorded, 65 were adults and 103 were juveniles. Dr. Sumner writes me that he listed mice as "juv." when "not in mature pelage; many of these were really post-juvenile." Thus in April the majority of foraging *sonoriensis* were probably less than four months old. Of 168 mice of this species, 84 were males and 84 were females.

Of 165 *Peromyscus e. eremicus*, 80 were adults and 84 were juveniles; 85 were males, 77 were females.

Record by Habitats, from "Live" (Delusion) Traps, made by Dr. F. B. Sumner in April, 1920, in Vicinity of Furnace Creek Ranch

| Species | Date | In or close about ranch buildings. | | Within cultivated area of ranch; mostly along irrigation ditches lined with arrow-weed; bermuda grass, alfalfa or grain fields adjacent. | | Along fence, cultivated ranch-land on one side, creosote (sandy) desert on other.[4] | | Along lines of mesquite and (or) arrow-weed on silty ground below (west of) ranch. | | Near border of borax flat west of ranch; strongly alkaline ground, with salt-grass, inkweed, or farthest mesquites. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traps out | Captured | Traps out | Captured | Traps out | Captured | Traps out | Captured | Traps out | Captured |
| *Peromyscus m. sonoriensis* | Apr. 5 | 15 | 27 | 51 | 15 | ...... | .... | ...... | .... | ...... | .... |
| | " 6 | 25 | 30 | 63 | 9 | 10 | 3 | ...... | .... | ...... | .... |
| | " 7 | 20 | 13 | ...... | ...... | ...... | .... | ...... | .... | ...... | .... |
| | " 8 | 20 | 9 | ...... | ...... | ...... | .... | ...... | .... | ...... | .... |
| | " 9 | 6 | 6 | ...... | ...... | 74 | 9 | ...... | .... | ...... | .... |
| | " 10 | 6 | 0 | ...... | ...... | 92 | 4[3] | ...... | .... | ...... | .... |
| | " 11 | 38 | 6 | ...... | ...... | ...... | .... | 60 | 1 | ...... | .... |
| | " 12 | 28 | 5 | ...... | ...... | ...... | .... | 70 | 4 | ...... | .... |
| | " 13 | 8 | 0 | 30 | 1 | ...... | .... | ...... | .... | 60 | 16 |
| | " 14 | ...... | .... | ...... | ...... | ...... | .... | ...... | .... | 97 | 10 |
| | Total... | 166 | 96 | 144 | 25 | 176 | 16 | 130 | 5 | 157 | 26 |
| *Peromyscus c. eremicus* | Apr. 5 | 15 | 0 | 51 | 24 | ...... | .... | ...... | .... | ...... | .... |
| | " 6 | 25 | 2 | 63 | 12 | 10 | 1 | ...... | .... | ...... | .... |
| | " 7 | 20 | 6 | ...... | ...... | ...... | .... | ...... | .... | ...... | .... |
| | " 8 | 20 | 6 | ...... | ...... | ...... | .... | ...... | .... | ...... | .... |
| | " 9 | 6 | 0 | ...... | ...... | 74 | 18 | ...... | .... | ...... | .... |
| | " 10 | 6 | 0 | ...... | ...... | 92 | 8 | ...... | .... | ...... | .... |
| | " 11 | 38 | 10 | ...... | ...... | ...... | .... | 60 | 22 | ...... | .... |
| | " 12 | 28 | 2 | ...... | ...... | ...... | .... | 70 | 8 | ...... | .... |
| | " 13 | 8 | 0 | 30 | 7 | ...... | .... | ...... | .... | 60 | 15 |
| | " 14 | ...... | .... | ...... | ...... | ...... | .... | ...... | .... | 97 | 24 |
| | Total... | 166 | 26 | 144 | 43 | 176 | 27 | 130 | 30 | 157 | 39 |
| *Reithrodontomys m. megalotis* | Apr. 5 | 15 | 0 | 51 | 3 | ...... | .... | ...... | .... | ...... | .... |
| | " 6 | 25 | 0 | 63 | 4 | 10 | .... | ...... | .... | ...... | .... |
| | " 7 | 20 | 0 | ...... | ...... | ...... | .... | ...... | .... | ...... | .... |
| | " 8 | 20 | 0 | ...... | ...... | ...... | .... | ...... | .... | ...... | .... |
| | " 9 | 6 | 0 | ...... | ...... | 74 | 0 | ...... | .... | ...... | .... |
| | " 10 | 6 | 0 | ...... | ...... | 92 | 4 | ...... | .... | ...... | .... |
| | " 11 | 38 | 0 | ...... | ...... | ...... | .... | 60 | 0 | ...... | .... |
| | " 12 | 28 | 0 | ...... | ...... | ...... | .... | 70 | 0 | ...... | .... |
| | " 13 | 8 | 0 | 30 | 1 | ...... | .... | ...... | .... | 60 | 0 |
| | " 14 | ...... | .... | ...... | ...... | ...... | .... | ...... | .... | 97 | 0 |
| | Total... | 166 | 0 | 144 | 8 | 176 | 4 | 130 | 0 | 157 | 0 |

| Species | Date | In or close about ranch buildings. | | Within cultivated area of ranch; mostly along irrigation ditches lined with arrow-weed; ber-muda grass, alfalfa or grain fields adjacent. | | Along fence, cultivated ranch-land on one side, creosote (sandy) des-ert on other.[4] | | Along lines of mesquite and (or) arrow-weed on silty ground below (west of) ranch. | | Near border of borax flat west of ranch; strongly alkaline ground, with salt-grass, inkweed, or farthest mesquites. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Traps out | Captured | Traps out | Captured | Traps out | Captured | Traps out | Captured | Traps out | Captured |
| *Perognathus f. formosus* | Apr. 5 | 15 | 0 | 51 | 1 | ...... | .... | ...... | .... | ...... | .... |
| | " 6 | 25 | 0 | 63 | 0 | 10 | 1 | ...... | .... | ...... | .... |
| | " 7 | 20 | 0 | ...... | ...... | ...... | .... | ...... | .... | ...... | .... |
| | " 8 | 20 | 0 | ...... | ...... | ...... | .... | ...... | .... | ...... | .... |
| | " 9 | 6 | 0 | ...... | ...... | 74 | 5 | ...... | .... | ...... | .... |
| | " 10 | 6 | 0 | ...... | ...... | 92 | 1 | ...... | .... | ...... | .... |
| | " 11 | 38 | 0 | ...... | ...... | ...... | .... | 60 | 0 | ...... | .... |
| | " 12 | 28 | 0 | ...... | ...... | ...... | .... | 70 | 0 | ...... | .... |
| | " 13 | 8 | 0 | 30 | 1 | ...... | .... | ...... | .... | 60 | 0 |
| | " 14 | ...... | .... | ...... | ...... | ...... | .... | ...... | .... | 97 | 0 |
| | Total... | 166 | 0 | 144 | 2 | 176 | 7 | 130 | 0 | 157 | 0 |
| *Onychomys l. longicaudus* | Apr. 5 | 15 | 0 | 51 | 0 | ...... | .... | ...... | .... | ...... | .... |
| | " 6 | 25 | 0 | 63 | 0 | 10 | 0 | ...... | .... | ...... | .... |
| | " 7 | 20 | 0 | ...... | ...... | ...... | .... | ...... | .... | ...... | .... |
| | " 8 | 20 | 0 | ...... | ...... | ...... | .... | ...... | .... | ...... | .... |
| | " 9 | 6 | 0 | ...... | ...... | 74 | 0 | ...... | .... | ...... | .... |
| | " 10 | 6 | 0 | ...... | ...... | 92 | 1 | ...... | .... | ...... | .... |
| | " 11 | 38 | 0 | ...... | ...... | ...... | .... | 60 | 0 | ...... | .... |
| | " 12 | 28 | 0 | ...... | ...... | ...... | .... | 70 | 0 | ...... | .... |
| | " 13 | 8 | 0 | 30 | 0 | ...... | .... | ...... | .... | 60 | 0 |
| | " 14 | ...... | .... | ...... | ...... | ...... | .... | ...... | .... | 97 | 1 |
| | Total... | 166 | 0 | 144 | 0 | 176 | 1 | 130 | 0 | 157 | 1 |

[3]Record not quite explicit; might have been caught in house.

[4]A bit of ambiguity in record here; some traps were set "between fields". When trapping was done, and the results recorded, it was not, of course, foreseen just how the ecological data would be classifiable.

The great increase in number of people within the past few years who visit Death Valley (40,996 in the season of 1934-35, October 1 to June 30) raises the question as to what influence this human invasion each winter may ultimately have upon the native animal life. Happily, Death Valley has been constituted a National Monument, to be administered under the National Park Service. This means that in normal course, under the fixed policy of this Service, there will be no more hunting or trapping of animals.

There presents itself next, then, the factor of habitat relations, and this may conceivably affect the fortunes of almost every animal in Death Valley. In my present paper on the mammals and the preceding ones on the birds, there has been brought out the principle of complete dependency of every kind of mammal and bird, directly or indirectly, each upon a more or less restricted type of environment. Upon which, and to what extent, then, among the animal habitats in the Valley, will human occupancy have influence?

The human draft upon the natural resources plainly involves two things, water and fuel. The chief native fuel source so far drawn upon is the immediately accessible mesquite, although the neighboring mountains could provide pinyon and mountain mahogany in quantity probably adequate now and for a long time to come. The mesquite supply is limited and already is approaching exhaustion locally. And the mesquite, as has been emphasized here and elsewhere, is doubtless the most important single plant component of animal habitats in Death Valley.

The mesquite is a notably water-dependent plant, though with its root system so extensive that it can go to great depths for water. Its distribution in Death Valley is obviously correlated with the presence of ground water within reach of its roots; the heaviest tracts of mesquite lie below the largest perennial springs and along the bases of the lofty Panamint Mountains. With human demand for, and diversion of, the limited water supply at its very sources, and the subsequent loss of the water largely by evaporation (rather than entry into the ground), one wonders what ultimately may happen to the water-table beneath the valley floor and consequently in future years to the tracts of mesquite with their dependent fauna. However, this is not, perhaps, a danger for most immediate concern.

With Death Valley made into a National Monument and rendered easily accessible in all its parts to visitation, *if* all its natural attractions are to be preserved, then a certain definite measure of wild life management must at once be practiced there, with all of the above ecological principles heeded. With view to helping toward establishment of such management, adapted to the conditions peculiar to this area, I ventured in November, 1933, shortly after returning from my last trip there, to submit the following set of suggestions to Colonel John R. White, Superintendent of the then just established Death Valley National Monument. I was gratified at the cordial reply received from Superintendent White;

indeed, in his letter, dated November 8, 1933, he gave it as his belief that from an administrative point of view every one of these suggestions were such as could be adopted.

These suggestions are incorporated here, therefore, not only as a matter of record, to review after the lapse of further years, but also as an illustration of how wild life studies may lead directly to considerations of an eminently practical bearing.

1. Develop flowing water from as many seepages, springs and wells, as possible, but reserve some of these watering places from regular human use, for the use of such native animals as require daily to come to water. Especially, reserve at least one watering place in each neighborhood entirely exempt from camping. Human presence usually means the frightening off of any bird or beast that otherwise would come freely to drink.

2. At "wild-life watering places" the issuing water should flow in part under protecting native vegetation. Most birds are very loath to drink or bathe in the open; they fear foes from the sky or from concealment on the ground near-by. Low spreading mesquite makes the best sort of protective cover; clumps of arrow-weed or cane are nearly as favorable.

3. Post signs warning tourists and campers not to cut or injure any living mesquite, screwbean, or arrow-weed anywhere in the Valley. Fuel can be derived for immediate use from dead parts of these plants, and especially from the long-dead stem parts of old salt-bushes, creosote bushes, and other desert shrubs. The mesquite is the most important to wild-life needs, of all the desert plants. All cutting of it for fuel, in any part of the Valley (and this should hold most rigidly for the humanly populated centers like Furnace Creek Ranch and Cow Creek) should be altogether prohibited. The mesquite grows slowly and replaces itself only under exceptionally favorable conditions. A long series of bird and mammal species is dependent directly or indirectly upon the mesquite, especially the older growths of it, for their subsistence. Conserve the mesquite and the animal numbers will be maintained. Eliminate the mesquite, and many of the most attractive and interesting kinds of birds and mammals must surely vanish.

4. The specialized, "relict" fishes in Salt Creek and Saratoga Springs are well worth making of "special feature" status. But they might easily be exterminated through heedless "development" of these waters in some way or other.

5. Needless to say, all hunting and trapping should be as strictly prohibited in Death Valley as in any other National Park area. This should apply to the ducks, doves and quail in the vicinity of Furnace Creek Ranch as well as elsewhere. The overflow ponds there, the plot of green, constitute a "lure" in the midst of the

desert, irresistible to migrating birds. Such lures should not be taken advantage of—save possibly in emergency by the Indians, on the ground that they may be considered to have natural rights which the alien white man certainly does not have.

6. Watering places for mountain sheep, adapted to their special habits, should be established at one or more points where tourists can visit them and thus see living wild Desert Bighorns. The animals would probably become tame in time, like those in the Rocky Mountain parks. Such special "tanks" for sheep would have to be maintained for this purpose alone. No camping or picnicking could be allowed.

7. The kitchen garbage (which is now incinerated) from Furnace Creek Inn should be used as at the "bear-pits" in Yosemite—put out in some ravine-mouth ¼ mile or so south of the Inn, to attract interesting animals night and morning. Such animals would be: Coyotes, Kit Foxes, Ravens, and Magpies. The Coyotes are known by tradition and through literature to most people; yet few persons ever have the chance to see one. Here these animals would, if regularly fed, soon become tame enough to be observed from near-by vantage-points. Ravens and Magpies, cleverest members of the bird world, are most amusing to watch. The resident park naturalist could make much "capital" out of this sort of attraction.

## **Myotis californicus pallidus** Stephens

### Desert Little California Bat

This was the only *Myotis* found by me on the floor of Death Valley, although several other species of this genus are known to occur in the mountains in the general region. Five specimens were taken on Furnace Creek Ranch, April 4 to 19, 1917. One of these was caught in a house and brought to me by an Indian. The other four were shot at middle or late dusk. As many as ten were seen in one evening (of April 6).

*Myotis* was wont to fly near the ground, around shrubbery, beneath trees, or low around the "weevilly" woodpile—not often above the skyline. Individuals were thus much more difficult to shoot than *Pipistrellus*. Compared with the latter bat, *Myotis* showed paler and broader wings. One was seen among mesquites around Triangle Spring at late dusk of April 16, 1917.

Of the five specimens of *M. c. pallidus* taken, two were females weighing 3.1 and 2.8 grams, respectively, and three were males, of weights 2.4, 2.6, and 3.4 grams. None was notably fat. The measurements of the five average: Total length 78 mm., tail 39, hind foot 5, ear from crown 10.7.

**Lasionycteris noctivagans** (LeConte)

Silvery-haired Bat

I did not find this bat in Death Valley until October, 1933. Its status there may thus be suggested as winter visitant or possibly migrant. In the afternoon of October 20, Mrs. Grinnell and I repaired to the "weevilly" woodpile on Furnace Creek Ranch. The evening was cooler than preceding ones and the sky was partly overcast with high cirrus clouds. Up to 4:40 not a bat was seen. Shortly, *Nycteris cinerea* came out (about 4 all told finally present), then *Lasionycteris* (about 4 all told), then *Tadarida* (fully 10 ultimately), and finally *Pipistrellus* (only about 6 on this date, until we gave up at late dusk because of eye-strain). On October 22, the first silvery-haired bat was out at 5:04 p.m., over the golf course; on the 27th, the first at 4:57.

*Lasionycteris* could be recognized far off by its broad wings, great extent of tail membranes, and its appearance of black color; its wing-beats, too, were relatively slow. Two were shot on that first night; both were males with testes small. One was notably fat and weighed 11.2 grams; the other weighed 8.7 grams. Two more taken, on October 28, female and male, weighed respectively 7.4 and 5.2 grams. The first was found by a boy in the daytime, at about 2 p.m., hanging twelve feet up, in the crotch of the stem of a tamarix tree; the second was shot at dusk above mesquites near an overflow pond west of the Ranch.

Average measurements of the four specimens taken were: Total length 98 mm., tail 40, hind foot 7.6, ear from crown 10.5.

**Pipistrellus hesperus hesperus** (H. Allen)

Western Canyon Bat

Both in April and in October, this was the most numerous bat seen on and near Furnace Creek Ranch. Flying as a rule above the horizon, specimens were easy to shoot against the evening sky. On some evenings of "bat-shooting" this was the only species of bat seen. As many as 20 individuals were counted in sight at one time. Some spent the day hanging among the reversed dead leaves of the Washington palms on the Ranch; others seemed to drift into the neighborhood from the direction of the Black Mountains.

In 1917, the first bat seen in flight on April 3 appeared at 6:20 p.m.; on April 4 at 6:03; on April 10 (with sunshine still on the eastern hills) at 5:55. At Salt Creek, April 13, the first were out at 6:20. At the same place two were shot on the evening of May 21. In 1920, two *Pipistrellus* were seen at late dusk of April 21, in flight near Bad Water,—280 feet. In 1933 on the evening of October 14, there were "swarms" among the tamarix trees and around the auto camp on Furnace Creek Ranch. On October 22, the first was seen abroad at 5:35p.m.; on the 27th, the first at 5:05. On October 24, one was seen in flight at 4:55 (well after sundown), at Triangle Spring. Recognition of this bat was easy, not only because of its small size, but because of its dark-colored, rather narrow wings; even though the wingbeats were usually rapid, the speed of flight seemed slow.

Of fourteen specimens preserved, 10 were males (reproductive organs inactive), 4 were females. All for which this point was recorded were lean. Their weights averaged 2.9 grams, varying from 2.3 to 3.4. Their measurements averaged: Total length 69 mm., tail 28, hind foot 5, ear from crown 8.6.

On the evening of October 27, 1933, at about 5:40 (late dusk), Mrs. Grinnell and I both saw against the western sky just off the northwest corner of Furnace Creek Ranch what we took to be a very large bat, bigger than anything we had seen here before. It hawked back and forth, now below the horizon then above—when suddenly it made an upward swoop and apparently captured a little *Pipistrellus*. Instantly, several other *Pipistrellus* which happened to be in the vicinity dived toward the captor, as if attracted by the cries or struggles of an unfortunate fellow. Then the whole group vanished to our sight down below the horizon and we were unable to discern anything further. We thought of *Eumops;* but still, the "capture" *might* have been an optical illusion!

## **Nycteris cinerea** (Peale and Beauvois)

### Hoary Bat

Prior to 1933, this winter-visiting bat was met with but once, on April 12, 1917, when one was shot at early dusk, flying heavily over the alfalfa field at Furnace Creek Ranch. This was a female, lean; weight, 19.8 grams. In October, 1933, from the 14th to the 28th of that month, every afternoon we looked for them, from one to four were to be seen in flight about the Ranch. One was shot on the 19th, a female, fat, weighing 27.1 grams.

This species was the first of the bats to appear of evenings: On October 14, at 5:20 (still broad daylight); on the 16th, at 4:00 (sun shining brightly and air still warm, about 80° F); on the 19th, at 4:00 (already abroad); on the 22nd, at 4:37; on the 27th, at 4:30; on the 28th, at 4:55. The species was easily recognized by its large size and broad and slow-flapping wings. The individuals would usually keep well up (25 to 100 feet above the ground); sometimes they would fly low and then, in the excellent light of early evening, their color tones and even the patterns on the wings could clearly be made out.

On the late afternoon of the 19th, Mrs. Grinnell and I took our stand in the Ranch wood-yard. The tiers of mesquite stove-wood gave forth sound like gentle rain, produced by the gnawings of innumerable larvae of powder-post beetles in it. Already at 4:00, two big *Nycteris cinerea* were coursing about within a short radius of the woodpiles, often so low as to be within easy "aux" range. By 4:40, there had been four of the same species about; then two *Tadarida* had appeared, and one *Lasionycteris;* by 5:20, *Pipistrellus* and *Myotis* had joined the throng, the former in profusion. It was the emerging adult form of the beetles that, of course, attracted all these bats into such concentration of numbers.

On October 27, the first bat to appear in the vicinity of the woodpile was a *Nycteris* at 4:30. A second of the same species appeared at 4:36, and later, just one other, making three individuals in all. They all had disappeared by 5:16, though other bats were by then out in numbers. It would seem that, a full meal obtained, these bats had gone to roost again, probably in the near-by palms or tamarix trees.

The average measurements of the two specimens preserved, females, were: Total length 133 mm., tail 54, hind foot 12, ear from crown 9.5.

### **Antrozous pallidus pallidus** (LeConte)

Desert Pallid Bat

Met with by us only on Furnace Creek Ranch, and there but twice. On each of the evenings of April 3 and 4, 1917, one was shot as it flew about at rather late dusk among and under the newly leaved cottonwoods. The first one, a female, weighed but 13 grams. The second one, a male, weighed 21.7 grams. The latter had in its mouth an inch-long moth-caterpillar, undoubtedly taken off the cottonwood foliage where, at the time, many such were to be seen. The measurements of the two specimens were, respectively: Total length 107, 102; tail 46, 43; hind foot 11, 10; ear from crown 28, 28.

In the winter of 1919, when Mr. and Mrs. Dane Coolidge were camped at Furnace Creek Ranch, they obtained a specimen of this species and later presented it to the Museum (no. 31146, male, alcoholic). On the evening of December 22, this bat flew down and lit on a board a few feet from the camp fire and was caught by hand. Another individual was seen flying about on the evening of the 26th. The Indians stated that this kind of bat flew about their fires "because it likes the smoke." More likely the object was to capture the insects attracted by the fire light.

**Tadarida mexicana** (Saussure)

Mexican Free-tailed Bat

This species was regularly seen over and around Furnace Creek Ranch, whenever bats were specially looked for, in both April and October. They would appear first of an evening in flight high overhead. I was told of colonies of bats roosting in old mine tunnels in the Funeral Mountains, whence these valley-foragers may have come.

*Tadarida* could be distinguished from all the other bats identified in Death Valley by the outline of the spread wings—extremely narrow fore-and-aft, with deeply incised posterior margins. The earliest seen on the evening of April 4 appeared at 6:05. On the morning of April 12, 1917, at 6:00, in broad sunshine, one was watched hawking back and forth over the alfalfa field where it was seen to capture insects.

On the afternoon of April 10, at 4:45 in full warm sunshine, two *Tadarida* appeared, foraging actively over the alfalfa. I had an idea at the time that these were abroad thus, extra early, because the gale the preceding night had kept them from foraging. Other individuals came out soon after these first ones. On the evening of October 27, 1933, at 4:47, a dozen or more *Tadarida* appeared high overhead, as if they had arrived from a distance in a flock. This bat did not show the degree of interest in the powder-post beetles emerging from the mesquite woodpile that the other species did.

Weights of four individuals (3 males, 1 female) averaged 9.4 grams. The male taken on October 27, 1933, and weighing 9.9 grams was fat; indeed it "oozed oil" from the shot-holes as it was picked up. Five specimens (4 males, 1 female) gave average measurements of: Total length 96 mm., tail 37, hind foot 8, ear from crown 13.

**Taxidea taxus berlandieri** Baird

Mexican Badger

Badgers are certainly not common in Death Valley, despite the abundance of rodents in certain parts of it. I, myself, saw the characteristic diggings only in the vicinity of Furnace Creek Ranch, in 1917. A setting of steel traps put out where there was such "sign", a mile or so southwest of the Ranch, on April 12 produced a young female badger, of 3500 grams (about 7.7 pounds) weight.

In photographing this animal, before it was killed for a specimen, Mr. Dixon found that it was quite "willing to fight" and would readily "fly at a person or stick." The odor or scent then thrown out was pervasive. The badger would hold its stubby tail directly aloft and a few seconds later the scent was plainly noticeable. The whole procedure was similar to that employed by a skunk, only the scent was not so strong.

In October, 1933, Mr. Monroe Wagnon told me that the summer before, he had met with a badger at night at a well he had gone to for water, two miles south of Tule Spring, on the Bennett Wells side of the Valley. He had recently seen tracks elsewhere on the Valley floor. Badgers are notable wanderers, and one might be encountered almost anywhere.

The specimen captured by us, a small female (no. 25914) probably less than a year old, measured: Total length 600 millimeters, tail 110, hind foot 90, ear from crown 32. In the pelt the white dorsal mid-line extends from the nose pad clear to the root of the tail, though becoming very narrow posteriorly.

[The badger is the only mustelid mammal to be reported from Death Valley. No skunk, either striped (*Mephitis*) or spotted (*Spilogale*), has, to my knowledge, been taken there, although I heard report of the latter species from the mountains in the general region—for instance from the Lila C. Mine. Neither has any weasel (*Mustela*) ever been reported from the immediate region.]

### **Vulpes macrotis arsipus** Elliot

Desert Kit Fox

The kit fox was undoubtedly the commonest carnivorous mammal in Death Valley. Its presence and relative numbers is probably pretty much controlled by the presence and relative abundance of nocturnally active rodents. If not the foxes themselves, then their footprints in sand or in dusty parts of roads or trails after nights when there was no wind, were seen at most places traversed. The frequent association of "sign" of kit fox with that of the two kinds of kangaroo rats was significant.

In the night of October 13, 1933, when sleeping out on the desert floor at the roadside a mile or so east of Stovepipe Wells Hotel, I was awakened about 2:30 a.m. by a rustling sound near by. "I turned on the 'flash'—to see a kit fox within 25 feet, nosing about a sardine can and paper wrappings we left out last night after supper. The animal seemed in no way alarmed, looked up once or twice, nosed along the ground; then trotted off into the gloom, tail up-curved but horizontal in general trend, ears conspicuously up-pricked, facial dark markings plainly seen. Once I saw the glowing pink eye-shine."

The evening of October 25, 1933, as we were driving south over the road approaching Furnace Creek Ranch, and within about four miles of the Ranch, we saw two kit foxes, in separate places, run across the road in the light of the auto. This was at 6:30 when, at that season, almost complete darkness had fallen. Everything indicates that this fox is wholly nocturnal in the time of its activity.

At Triangle Spring, on April 17 and 18, 1917, Mr. Dixon caught two kit foxes in steel traps set near burrows of the big desert kangaroo rat. The bait used was portions of a jack rabbit. These two foxes were probably a mated pair, although they showed no signs of immediate breeding. The data accompanying the specimens are as follows. Male (no. 25903), weight 1531 grams (about 3⅓ pounds); total length 715 millimeters, tail 293, hind foot 114, ear from crown 84. Female (no. 25904), weight 1406 grams (a little over 3 pounds); total length 710 millimeters, tail 275, hind foot 110, ear from crown 85. In color of pelage and other features, these specimens are quite like others from the western parts of the Mohave Desert. An additional skull-only at hand (no. 31145) was from a yearling animal trapped by an Indian for fur near Furnace Creek Ranch about December 15, 1919. This skull was retrieved for the Museum by Mr. and Mrs. Dane Coolidge.

[While I saw a pelt of a gray fox (*Urocyon*) which had been trapped in the hills somewhere west of Death Valley Junction, I heard of none of this species ever having been seen or taken in the Valley proper.]

### **Canis latrans estor** Merriam

#### Desert Coyote

There was no place at which we camped or scouted about in Death Valley, save Bad Water, where we did not find sign (footprints or foeces) of coyotes. Additionally, their voices were heard frequently in the night. On one occasion, October 24, 1933, at Surveyors Well, we heard a coyote at 8:40 a.m. of a brightly sunshiny day, yelping and barking persistently from the direction of the sand dunes and mesquites out on the floor of the Valley to the westward. Rarely did we actually see one of the animals. In the early morning of October 27, 1933, at 5:45 o'clock, we saw one as we were driving south along the road within half a mile of Furnace Creek Inn. It was near the site of a garbage incinerator, and we could see it plainly, despite the dusk, at about 50 yards distance because outlined darkly against an expanse of light-colored rock at the base of the hill.

West of Furnace Creek Ranch, we could always find tracks of coyotes where the ground was soft, weaving in and out between the arrow-weed clumps and the mesquites—doubtless a productive forage ground. After still nights, footprints were to be seen meandering over sandy areas where kangaroo rats were plentiful, and also along dusty burro trails through the scanty salt-grass (as down close to the edge of the "self-rising" flat,—240 feet, west of the Ranch) where jack-rabbit sign was fairly plentiful.

Along Salt Creek, on October 30, 1933, there were many fresh coyote tracks in the slimily wet alkali mud along the channels through the pickleweed and cane. We imagined the attraction here might have been crippled birds, besides mice; for we saw evidences (empty shells) that there had been shooting there that autumn—indeed we ran across one wounded duck, a baldpate. At Triangle Spring and elsewhere, coyote tracks often led to potable water. This and other evidence guides me to the belief that *Canis* is one of the very few desert mammals that needs regularly to drink.

Foeces of coyote found both in April and October consisted either entirely or in considerable part of the resistent seeds, and the chewed-up remains of the pods, of the mesquite. At a defoecating post I found April 16, 1917, on a flat rocky outcrop on the edge of the low mesa near Triangle Spring, was an accumulation of "turds" consisting of remains of mesquite bean-pods, some feathers, and bones of small mammals among which I was able at the moment to recognize only rabbit. Near Furnace Creek Ranch, April 10 to 13 of the same year, the carcass of a dead calf was being, as shown by the tracks, patronized nightly by one or more coyotes.

In 1917, on April 11 and 13, and May 3, Mr. Dixon trapped three coyotes in the neighborhood of the Ranch. All were adult females; the data obtained from them were, in the same order, as follows: Total length 1090, 1120, 1118 millimeters (43 to 44 inches); tail (without hairs) 320, 340, 320 (about 13 inches); hind foot 170, 185, 182; ear from crown 110, 115, 111. The weights were, respectively, 7.2, 8.8 and 7.9 kilos (about 16 to 19 pounds). The pelts were, at this season, in exceedingly worn and faded condition. In the first one taken, the guard hairs along the sides, and on the tail, were almost all shed, leaving the gray underfur exposed, and this was sluffing off in patches.

The coyotes of Death Valley, judging from the three skulls obtained (nos. 25896–98), belong to the small southwestern desert race with weak dentition, now called *estor*, rather than to the larger, heavier-toothed race of the Great Basin, *lestes*.

### **Lynx rufus baileyi** Merriam

Desert Wildcat

On April 21, 1917, Mr. Dixon caught an old female wildcat in a setting of steel traps placed near wood-rat houses under thick mesquites west of Furnace Creek Ranch. The weight of this animal was 7200 grams (about 16 pounds). Dimensions: Total length 850 millimeters (about 33½ inches), tail 170, hind foot 173, ear from crown (without tuft) 80. The pelt of this example (no. 25918) was seasonally deteriorated to an extent that the long overhairs as normally present in a prime skin are reduced in quantity and the remainder shortened by wear, with the result that it is mainly the pinkish color of the underfur that is shown on most of the surface of the animal. There is also at hand a skull-only (no. 31144) of a yearling wildcat trapped for fur by "Shoshone Johnny", an Indian, 3 miles south of Furnace Creek Ranch about December 15, 1919. This skull was received through the kindness of Mr. and Mrs. Dane Coolidge.

Tracks of wildcats were seen in both 1917 and 1933 on soft silty ground in the tracts of mesquites in the vicinity of the Ranch. They were also reported to me from Triangle Spring, and from around the big springs up out of the Valley at the sources of Furnace Creek. Heavy cover of brush seems to be a desirable feature of the habitat of this carnivore—where not only shade but abundant rodent life is available.

### **Homo sapiens americanus** Linnaeus

American Indian

The natives of Death Valley belong to the Shoshonean stock, to the Plateau branch of this stock, and to the Koso dialect group within the Shoshoni-Comanche division of that branch. This is the classification offered by Kroeber (Handbook of the Indians of California, Bull. 78, Bur. Am. Ethnology, Smithsonian Inst., 1925, pp. 574–592). Kroeber also gives facts, but all too meagerly, concerning the natural history of this original people of the Death Valley region—their habitat-relations, the sources of their subsistence, their "manufactures." My own regrets are deep, that I did not, during my first two trips into the Valley, take opportunities then offering to learn more about the dependences of the few Indians I met, upon the natural resources of the country. I did observe that in April the women and children were actively trapping rodents in the mesquite thickets around Furnace Creek Ranch. *Neotoma* and *Ammospermophilus* were the kinds mostly sought and caught—in deadfalls each consisting of a flat rock. These, along with lizards of the larger kinds caught with nooses, were boiled in kettles and eaten. Many such animals were brought to my camp, in-as-much as I was paying for certain things, mostly reptiles, to preserve as specimens.

### **Citellus tereticaudus eremonomus** Elliot

Death Valley Round-tailed Ground Squirrel

In my experience in Death Valley, this rodent was one of the rarest mammals there; at least it successfully eluded detection to a remarkable degree, even when concentratedly searched for. None was found anywhere we trapped or hunted apart from the near vicinity of Furnace Creek Ranch, −150 down to −200 feet altitude. Here this squirrel was restricted to hillocks of wind-accumulated sand under those mesquites that, perhaps in consequence of the rising sand masses about their bases, had assumed a sprawling habit of growth. No *Citellus* was seen on the clayey or silty type of ground where the mesquites grew tall. The critical factor here may have been level of food source; no *Citellus* was seen to climb; and as evidence from my notebook shows that the food, at least in spring, consisted entirely or mostly of the leaves of the mesquite, it would seem likely that the squirrels would limit their range locally to those mesquites the branches and foliage of which trailed on the ground. Then again, the better texture of the sand dunes for entry by a weakly equipped digger, as compared with the often firmly caked clayey earth, may have contributed to the notable habitat-restriction of this rodent.

*Citellus* was observed to be active in the limited neighborhood above indicated in April and early May, 1917, and in April, 1920; yet repeated search over exactly the same ground in October, 1933, revealed not a trace of the animals: no tracks, no burrows—which, of course, the recurrent two-day gales would serve to efface when not in use—and no voicings (though in that month the very different trills of *Ammospermophilus* were heard abundantly). It is quite likely, therefore, that the Death Valley *Citellus* goes into dormancy for part of the year, beginning possibly in late summer when the mesquite foliage begins to deteriorate as food, and tiding the animals over the winter period of leaflessness in that plant.

I gathered the following habit notes concerning the Death Valley round-tailed ground squirrel in the spring of 1917. The daily program of activity of the animals seemed to be correlated directly with the rising of the temperature of the air; they were not noted at all early in the morning when we went the rounds of our traps, and their voices were to be heard most frequently in the heat of midday, which on some of the days in April rose well above 100° F. in the shade. On April 10, during a two-hour hunt around noontime, at least five individuals were heard or seen on the mesquite-crowned sand dunes within a mile southwest of the Ranch as it was then developed. The warmth of that day had seemingly brought them out; for the previous two or three days had been relatively cool and none had been noted. I caught sight of one standing upright at the mouth of its burrow, squeaking, and of two others running over the sand beneath the trailing mesquite branches. The lines of footprints in the sand centering at the mouths of their burrows are diagnostic (as compared with those of *Dipodomys*, for instance). The animals are extremely shy, going below-ground at the slightest alarm. By standing ten minutes or so "at attention" about fifteen yards from the mouth of a burrow down which one had vanished, I finally saw the top of its head emerge to the level of its eyes. This position it maintained for many minutes, until the animal suddenly raised its whole head and neck into view, when I shot it.

Later, while I was lying prone on the sand under a mesquite, a *Citellus* came up through the screening foliage to within eight feet of me and gave its shrill, wiry cry, or squeak. A slight movement on my part, and it vanished, quick as thought. By April 22, I found that a little "screeping" (lips to back of hand) would often bring one of the squirrels stealthily "investigating" through the tangle, *provided* the observer kept perfectly motionless himself and was possessed of patience—a difficult feat, for the dead heat in those half-shaded mesquites was "terrific", and "the intense sweetish smell of the blossoms then coming out in profusion almost overpowering"; and there were gnats! The squirrel would sometimes squeak, apparently in answer to my "screep", and thus be "called" into very close "aux" range.

The burrows were as a rule situated in the periphery of a large mesquite clump where they were shaded by the radiating leafy branches which extended down the slopes of the appertaining sand hillock. Not more than three burrows certainly of this rodent were found at any one clump, and all of these entrances probably belonged to one animal. The mesquites during early April were just coming into full new foliage. The stomachs of the squirrels shot were distended with masses of finely chewed mesquite leaves—nothing else. In one instance, the total weight of the freshly killed animal was found to be 154.5 grams; of the full stomach alone, 28.7 grams or 19 per cent (near one-fifth) of the total weight. In other words, an individual squirrel of this species may eat close to one-fourth its own net weight of green mesquite leaves "at one sitting". Incidentally, out of the nine specimens of *Citellus* taken, only two (and one of these the only male taken) were caught in traps, although many traps were set for them, baited variously. At least at this particular season, it would appear that rolled oats and the like hold little attraction.

No young *Citellus* were seen. Two of the females shot, of dates April 10 and 12, contained, respectively, four and three large embryos.

An adult male trapped April 7 and "sun-cooked" (saved as a skeleton-only) weighed 101 grams and gave measurements as follows: total length 220 millimeters, tail 80, hind foot 36, ear from notch 5. Eight adult females taken April 10 to May 3 weighed 121 to 158 grams, averaging 144.3. Their measurements in millimeters (average, minimum and maximum) were: total length 249 (240-255), tail 91 (87–95), hind foot 35 (34–36), ear from crown 2.1 (2–3).

This subspecies of the round-tailed ground squirrel is of darkest color tone, near wood brown, in both winter and summer pelage. Especially is this darkness apparent in comparison with the race on the Colorado Desert, and it is hard to account for. The sand surface in Death Valley *looks* as glaringly white as the sand surface in the vicinity of Salton Sea! No other race of mammal in Death Valley is characterized similarly in comparison with its adjacent races. *Citellus tereticaudus eremonomus*, as yet known, has the smallest range of any desert kind of mammal in California. It is probably a relict or disappearing stock. Incidentally, the type specimen (Elliot, Field Columb. Mus., zool. ser., vol. 3, December, 1903, p. 243) was one of three collected at Furnace Creek Ranch in 1903, by Edmund Heller. It is now no. 12862, Field Mus., and was taken April 29. According to Heller's notes published later, "The Indians catch them [*Citellus*] for food in dead-fall traps, and their shyness and scarcity is apparently due to constant persecutions of this character" (Elliot, Field Columb. Mus., zool. ser., vol. 3, 1904, p. 291).

The time of the spring molt in *eremonomus* is indicated by a specimen of date April 10, in which new, summer pelage is showing on the head, lower sides and rump; an example taken May 3 is in complete new, short summer pelage except for the tail, which seems to retain the winter pelage, becoming faded and frizzled, until the time of the fall molt—whenever that may occur. One specimen has the tail bobbed (to 40 millimeters vertebral length), and the end is adorned with a short thick brush of hairs which are white-ended, black at bases. Most of the skins show a curious spotting of the rump region. This is clearly due to the presence of places where groups of hairs are absent, so that the dark-colored skin and dark bases of the posteriorly rooted hairs show through. These spots may indicate scars from insect bites.

### **Ammospermophilus leucurus leucurus** Merriam

Desert Antelope Ground Squirrel

The antelope ground squirrel, or "desert chipmunk", is common and widely distributed in the mountains all about Death Valley up to an altitude of 6000 feet or more. While locally common in the Valley proper, there were long stretches of the below-sea-level area traversed by us on which we saw no individuals whatsoever, and no sign of any. They were common, however, along the northeast side of "Mesquite Arm" of Death Valley, from the vicinity of old Stovepipe Wells nearly to Surveyors Well; also in the neighborhood of Furnace Creek Ranch.

As with so many other animals, the mesquite affords "ammo" a requisite measure of food and shelter; but, showing wider adaptability than some mammals, ammo was also seen away from the mesquites, where there were only arrow-weed clumps, or creosote bushes. Burrows were seen in level silty ground, on the sides of mesquite-crowned sand-dunes, and in hard-pavemented stony ground. Usually a burrow opened at the side of, or from under, a brush-clump, perhaps to give better protection against digging enemies.

Ordinarily when caught sight of, a chipmunk would be scurrying across open ground from one bit of cover to the next. Then it was the brilliantly white under surface of the tail which caught the observer's eye; for the tail is held "plastered" flat up over the animal's rump, and it is continually twitched. This factor of *motion*, in evidence also even when the animal has stopped in the shade of a bush, makes of this white under tail-surface a veritable "flag."

*Ammospermophilus* is rather prone to climb; individuals were frequently seen up in the tops of low bushes and occasionally in mesquites. For example, on April 5, 1917, my eye was caught by the tail-twitching of an ammo, otherwise "frozen", crouching against the slanting stem of a mesquite, some two feet above the ground.

Aside from the coyote and Indian, the antelope squirrel may be signalized as the most *vocal* mammal in the native fauna of Death Valley. In October as well as in spring, the ammos were to be heard more generally out on the desert around Furnace Creek Ranch, than most birds even. The utterance may be described "as a prolonged mellow rolling trill, weakening or falling in inflection toward the end. The tone is maintained on about the same moderately high pitch throughout, though an impression of lowering may be received because of the progressive diminution in volume [of sound]. The sound is of a quality to carry well, yet even at very close range it rarely seems loud." (Quoted from Grinnell and Dixon, Natural History of the Ground Squirrels, 1918, p. 691.)

"Singing" as described, and foraging, were activities most plainly sensed by the human observer during the early forenoon. Yet our trapping showed that the squirrels were searching for food all through the daylight hours. They readily entered our rolled-oats-baited traps, left unsprung through the day; and many of the animals were thus unintentionally killed, quickly to be "sun-cooked" and so spoiled for specimens.

West of Furnace Creek Ranch, the local range of *Ammospermophilus* extended down to the very edge of the borax flat, −240 feet. Here burrows were seen (April 10, 1920) in silty, alkali soil at the bases of the farthest, dwarfed arrow-weed clumps. On the meager mounds at the mouths of these burrows many hulls of mesquite seeds were noted; and I wondered whether the ammos had gone all the way across the several hundred yards of terrain to the nearest mesquite trees in sight. Presently, a better explanation presented itself. At night, burros come down to the edge of the borax flat to graze on the sparse salt-grass there. In the daytime these burros seek shade back in the mesquite thickets, where they feed extensively on the mesquite beanpods, often filching these from the piles stored by the wood rats on their houses under the trees. I saw that the droppings of the burros scattered along their regular routes of travel contained many of the hard-shelled, digestion-defying seeds of the mesquite; for it is the sugary, pithy part of the beanpod that furnishes nutriment to the burro. The ammos forage along the burro trails for the seeds (to store away below-ground) thus provided second-hand, even third-hand in cases where the wood rats had done the initial gathering! I even wonder whether there could persist that submarginal population of antelope squirrels, without the agency of the burros as conveyers of the mesquite seeds.

An enemy of ammo is indicated by the following incident. A Cooper hawk shot by Mr. Dixon in the early evening of April 11, 1917, in a line of mesquites west of the Ranch, held in its gullet the finely cut-up remains of an adult *Ammospermophilus;* the two hind feet of the animal had been swallowed entire, and these afforded certainty of identification.

The only breeding data concerning this rodent available from Death Valley is furnished in connection with the record of a specimen taken on April 23, 1917. This was a young female only about one-fifth grown (total length 130 millimeters, weight 17.7 grams) yet found wandering about under a mesquite near the Ranch. Even though feeble, this little squirrel persisted in holding its tail at all times over its back in characteristic ammo fashion. The date of its capture indicates breeding of the species here as early as the latter part of March.

Of the twelve adult specimens saved, the seven males gave weights of 96 to 119.1 grams, averaging 101.8; the five females, 89.5 to 115, averaging 100.7 grams. The measurements, in millimeters, of the two lots are, average and extremes: Males, total length 228 (219–255), tail 65 (62–70), hind foot 37 (35–39), ear from crown 6 (5–7); females, total length 217 (210–225), tail 61 (54–65), hind foot 36 (35–38), ear from crown 6 (4–8). It would appear that males are slightly larger than females.

Three of the males and one female have bobbed tails, and the dimensions affected are, of course, not included in the above figures. The injuries causing such mutilation were doubtless incurred postnatally and may have been suffered in fighting. The shortened tails are adorned with square-ended tufts of extra long hairs. These tufts are white-tipped and banded broadly with black subterminally. One wonders if the individuals thus mutilated for life, are in any degree thereby at a disadvantage, socially or as regards hazards of existence.

### **Perognathus formosus formosus** Merriam

Utah Long-tailed Pocket Mouse

Only two kinds of pocket mouse have been found to occur on the floor of Death Valley, and even these two appear to be much restricted in local range. This is curious, because the surrounding desert region abounds in this group of rodents, represented in different habitats by at least four species. The present species was taken by myself and associates only in the near vicinity of Furnace Creek Ranch and near Bad Water, the lowest place in the Valley. Trapping records definitely show its presence to be controlled by terrain of gravel or coarse sand, seemingly quite independent of kind of vegetation in reach. In the few cases where individuals were trapped on fine sand or silt, the places of capture were near-by to sandy or gravelly creosote or to desert holly (rocky wash-fan). None was found on sand dunes. I got the idea that *Perognathus formosus* was found around Furnace Creek Ranch so far out of its normal habitat because there was no fine-sand-dwelling species of *Perognathus* there, such as elsewhere is complementary in local distributional restriction to *formosus*. There was no competitive exclusion.

On the night of April 21, 1920, at "Bad Water" of the U.S.G.S. map, Dr. Sumner put out a line of 55 traps. These were scattered over all sorts of accessible ground, mostly on the wash-fan at the base of the precipitous wall of the Black Mountains. Next morning, the total result was one adult male *Perognathus formosus*, from a mousetrap under a desert holly bush on the lower border of the fan very near to the level of the flat; hence nearly −280 feet altitude. Ant-hills in the vicinity consisted of the shells of the seeds of this plant (*Atriplex hymenelytra*), and we supposed that the mice resorted to this source of food also.

Two females, taken on April 13 and 22, respectively, each contained 3 embryos. No young had appeared abroad up to the end of April.

Of 20 specimens of *Perognathus formosus formosus* preserved as skins, all adult, dates April 4 to 22, thirteen are males and 7 are females. Their weights were, for the males 13.4 to 19.1 grams, averaging 16.3; for the females 12.3 to 19.5 grams, averaging 15.6. Measurements in millimeters: Average and extremes for the males, total length 186 (175 to 195), tail 103 (95 to 105), hind foot 23.7 (23 to 24), ear from crown 8.6 (7 to 9.5); for the females, total length 183 (174 to 192), tail 102 (90 to 110), hind foot 23.6 (22 to 24.5), ear from crown 8.3 (7 to 9). In certain of the specimens the pelage has a "burnt" appearance; that is, instead of the rather clear grayish tone characteristic of this pocket mouse in fresh coat, it is of a clay color. This "yellowing" may, as with *Dipodomys*, be an effect of living in strongly alkali ground.

## **Perognathus penicillatus stephensi** Merriam

### Stephens Desert Pocket Mouse

All our trapping in Death Valley produced just one example of this pocket mouse. In 1917, I visited the type locality of it, vicinity of Triangle Spring, for the express purpose of obtaining topotypes. Four nights were spent there, April 15 to 18, with a total of 381 trap-nights (Mr. Dixon was then with me). Result: no. 26532 (orig. no. 4153 J.G.), adult male; weight 11.6 grams; total length 165 millimeters, tail 94, hind foot 21, ear from crown 4.5. Pelage dorsally of extreme "alkalied" tone of color, approaching pinkish cinnamon, this invading the dorsal surface of the tail and its entire tuft. That this color is extrinsic, pertaining to the old coat, is shown by the presence of a small patch of new pelage on the top of the head between the eyes. This is of lined, avellaneous tone (toward gray) like non-alkalied specimens of *stephensi* from Barstow and Victorville, on the Mohave River.

This rarity was taken on the morning of April 16 from a mouse trap set the preceding evening at a little hole in a south-facing sand heap crowned by scrubby mesquite. The place was near the foot of the low bluff, on the general level of the lowest desert floor, perhaps a mile south of Triangle Spring as now dug out and so posted; we called its altitude −13 feet. The "hole" had no mound in front of it, nor were there any tracks showing, though the wind would have quickly effaced any left there. It was rather indefinite, as though a lizard might have used it; indeed the mouse *might* have had nothing to do with it.

However, on a chance, we dug it out. It extended into the mesquite mound about 6 feet, reaching a depth from the surface, of 18 inches. There were two blind branches, one forming a chamber 3 by 6 inches, but empty. The mouth of the burrow within 3 inches of which the lucky trap was set, was 30 millimeters high by 37 wide. The mesquite mound was found to consist, very porously, of alternate layers of dry mesquite leaves and twigs, and sand, this showing the manner of growth of such a mound. The burrow followed mostly one or another of the layers of leaves and twigs, already loose and almost open enough in places for a mouse to go through without digging. Although we found nothing conclusive as to the ownership of this particular burrow, the conditions described may be of the kind requisite for the day-time shelter of this type of rodent, of weak digging powers.

In the fall of 1933, with Mrs. Grinnell, I again visited Triangle Spring, and we ran traps there especially for *Perognathus*. A total of 150 trap-nights, October 23 to 25, produced—nothing!

The type specimen of *Perognathus stephensi* (this form was at first thought to be a full species) was taken, together with one cotype, by Frank Stephens on April 6, 1891 (Merriam, Proc. Acad.

Nat. Sci. Phila., 1894, p. 267). Under date of February 26, 1917, in reply to my request for further information concerning his original capture, Mr. Stephens wrote me from San Diego as follows: "On this part of the trip [Death Valley Expedition] I was coming down from the Grapevine Mountains, travelling southward to get to Furnace Creek. I left Grapevine Spring in the morning [of April 5], passed the 'lost wagon' about noon, and along in the afternoon found a little spring where others had camped . . . . As I now remember it, this little spring was at the edge of a low mesa . . . . I remember that there were a few smallish mesquite trees scattered about, and I think a few sand drifts in the hollows and low gulches of the mesa . . . . The spring I camped at . . . was not a rise of the creek out in the flat, but was near or at the edge of a little mesa, perhaps at the mouth of a draw . . . . [From there] it took me the best part of a day to reach Furnace Creek. . . . I put out my traps along the edge of the mesa and in the gulches."

This description enables one today very closely to fix the exact place whence came the type of *Perognathus penicillatus stephensi* Merriam. From what is now known, I would judge the subspecies to have its metropolis in the general depression into which the Mohave River at one time flowed, and of which the lowest part is Death Valley.

*Addendum.*—Being informed of the extreme rarity of *Perognathus penicillatus stephensi* in Death Valley, Miss Annie M. Alexander and Miss Louise Kellogg, in February, 1936, undertook to try their skill toward obtaining additional specimens of this mouse for the Museum of Vertebrate Zoology. Taking with them a copy of the manuscript of my account as just given above, this providing the gist of previously accumulated information concerning the species to be sought, they made their headquarters at the Stovepipe Wells Hotel, in the northern end of the Valley.

The evening of February 13, 123 standard mouse traps were put out on ground about one-fourth mile north of the hotel, across the flying field, averaging in altitude about −11 feet. Next morning, Miss Alexander found a *stephensi* caught in one of her traps set "about half-way across the comparatively narrow strip of atriplex and creosote between the landing field and some bare sand flats." The trap was at the south base of a sand hillock, under the drooping branches of an atriplex bush. [Sample of this bush saved, showed it to be of the species *Atriplex canescens*.] The mouse's pockets were full of the bait, rolled oats. Another trap in the vicinity, unsprung, had small tail marks about it, but possible *Perognathus* sign otherwise was not noted. On the evening of February 16, 65 traps were put out over about the same route, but no pocket mouse was caught. Miss Alexander's notes state that "very little alkali showed where the traps had been set; there were some spots blown bare, but the surface of the ground was mostly covered with fine yellowish sand." This is significant in that the specimen taken is in scarcely any appreciable degree yellowed ("alkalied"). Other rodents caught in this place, incidentally, were only of the species *Dipodomys deserti*, five of them: results of 188 trap-nights.

On the nights of February 14-15 and 15-16, intensive trapping was done around Triangle Spring, which is close to 15 miles by road from Stovepipe Wells Hotel. On the morning of the 15th, Miss Alexander was again successful in obtaining a *stephensi*, from the line of 79 traps put out. This was in a Benson type of "live" trap, set at a clump of dead arrow-weed about 5 by 8 feet in diameter, on a slight mound of sand, altitude −25 feet (estimated), about 950 feet (measured) northwest of Triangle Spring. The trap had been placed "on the northeast side [of the clump], facing the entrance to a runway that ran . . . under overhanging dead branches of arrow-weed for about five feet to a hole an inch or more in diameter that appeared to head toward the center of the clump, which was a tangle of salt-grass and dead branches. There were two other narrow runways on the northeast side that disappeared in the thicket; an atriplex bush sheltered the long runway on the outer side." That these runways had anything to do with the *Perognathus* is, of course, problematic. The following night, the successful trap was reset in the same spot as the day before, and another one near the end of the runway described. Next morning these traps were sprung but empty; another trap out of the 75 put out in the vicinity that second night, set at an arrow-weed bush about 15 paces south of the particular arrow-weed clump in question, caught a *Peromyscus maniculatus*. Another trap held a *Dipodomys merriami*. The first night's line of traps had produced, besides the *Perognathus*, five *Peromyscus maniculatus* and one *Dipodomys merriami*.

Meanwhile, on the evening of the 14th, Miss Kellogg put out 94 traps along a narrow line of dunes about one-fourth mile west of Triangle Spring. These produced only *Peromyscus maniculatus* (3) and *Dipodomys deserti* (1). The following evening she selected a new trapping ground, along the road about six-tenths of a mile southeast of Triangle Spring, altitude about −13 feet. Here she put out her 94 traps, some of them at bases of small sandy hillocks heaped up around arrow-weeds, some at larger mounds covered with mesquite, and others under arrow-weeds and near mesquite clumps where there were no wood-rat houses. The morning of the 16th brought one *Peromyscus maniculatus* (in a Benson-type trap at an arrow-weed clump) and one *Perognathus*. This latter was "in the 68th [standard] mouse trap set out, about 50 feet north of the road, under an arrow-weed growing on the edge of a small wash and near a sandy hillock covered with mesquite . . . . There was no hole near the arrow-weed, so it may have come from the hillock."

The three examples of *Perognathus penicillatus stephensi*, resulting thus from 530 trap-nights of special effort, reached the Museum in perfect condition. The data accompanying them are as follows.

| No. MVZ | Orig. No. | Sex | Locality | Date | Weight (grams) | Total length | Tail | Hind foot | Ear from Crown |
|---|---|---|---|---|---|---|---|---|---|
| 70122 | 3082 A.M.A. | ♂ | Stovepipe Wells Hotel....... | Feb.14,'36 | 11.7 | 166 | 95 | 22.5 | 5 |
| 70120 | 3083 A.M.A. | ♂ | Triangle Spring | Feb.15,'36 | 11.5 | 167 | 96 | 23.0 | 5 |
| 70121 | 3085 L.K. | ♂ | Triangle Spring | Feb.16,'36 | 13.0 | 171 | 95 | 23.0 | 5 |

While all three of these examples are adult, the last is decidedly the older, as shown by the much greater degree of wear on the crowns of its molariform teeth. The first two may have been about one year old, the last, two years old, or older. The color tone of the pelage varies, but in none is it anywhere near as "alkalied" as in the example I took (no. 26532), on April 16, 1917—thus two months later in the season. The one taken by Miss Kellogg, a little southeast of Triangle Spring, is darkest, clearest avellaneous in color tone, almost identical with specimens of *stephensi* in hand taken March 15 to 17, 1914, near Barstow, on the Mohave River. No. 70122, from Stovepipe Wells Hotel, is nearly as dark; but no. 70120, from a little northwest of Triangle Spring, is decidedly on the alkali side, showing a distinct pinkish buff suffusion. Two months later, this mouse might have reached the condition of no. 26532.

### **Dipodomys merriami merriami** Mearns

Merriam Kangaroo Rat

This smaller of the two species of kangaroo rats present in Death Valley was the more widely spread of the two, apparently because it could get along with less depth of diggable soil—silt or sand. The big *deserti* required veritable mounds—ideally sand dunes. *Merriami* could "dig in" where there was only a shallow accumulation of wind-carried silt or sand about the base of a creosote, atriplex or arrow-weed clump. Easily recognized "sign" consisted of open mouths of burrows in such accumulations with, after quiet nights, clearly defined hind-foot and tail tracks about them. The lesser foot-print length easily distinguished *merriami* from *deserti*.

Thus, without the results of any trapping, it was easy to see where the Merriam kangaroo rat abounded. This, as indicated, was over most of the floor of the Valley, save on the "borax" flats and on stone-pavemented wash-fans where there were no patches of loose soil at all. Since tracks were seen after windless nights on dusty or sandy surfaces hundreds of yards from any detected burrows, it is to be inferred that individual *merriami* has a long cruising radius. This gives it access to a large area such as must be covered to collect sufficient seeds in the long periods between crops, when the seeds from the sparse vegetation have been widely scattered, and buried and exposed again, by the alternating south and north winds. It would seem that from the *Dipodomys* standpoint, Nature had hit upon the most economical and efficient sort of way to support a continuing population of these spermophilous rodents. Or, to put it more biologically, "dipo" has specialized in cruising equipment (speed, noiselessness, capacious cheek pouches for carrying loads of seeds) enabling it to glean from a large acreage of meager food production. That there is success and an enlarged measure of individual safety in this attainment is indicated by the relatively large as well as widespread population in spite of low birthrate.

In the north end of Death Valley, in the vicinities of Triangle Spring and Surveyors Well, *Dipodomys merriami* was found on and around the mesquite-crowned sandhills far out across Salt Creek, as well as here and there on the sloping mesa well up toward the Grapevine Mountains, then, of course, above sea-level. Around Furnace Creek Ranch, the species was common in the mesquite tracts, whether on sandy or silty ground, and individuals were trapped or sign was seen down to within a few yards of the edge of the "self-rising borax", altitude −240 feet. The individuals taken here showed reddish color-tone of upper surface and tail tuft, which seems to be correlated with the presence of much "alkali" in the soil in which the animals live.

Of 20 females trapped, and of which record was kept, from April 5 to April 21, seven were pregnant. In four there were two embryos each, in three females there were three embryos each. As early as April 8, a young-of-the-year already two-thirds grown (weight 22.5 grams) was taken, betokening the beginning of the breeding season back in middle or even early March. By April 22, immature individuals were abroad commonly.

The 38 adult specimens of *Dipodomys merriami merriami* preserved from Death Valley furnish the following figures. Twenty males averaged in weight, 41.2 grams (extremes 34.0 and 49.5); eighteen females averaged 38.3 grams (range, 32.0 to 46.3). Measurements, in millimeters, of the same two groups: Males, total length 246 (225–270), tail 143 (125–160), hind foot 38.3 (36–40), ear from crown 10.8 (9.5–13); females, total length 241 (225–250), tail 139 (123–150), hind foot 38.5 (36–40), ear from crown 11.4 (10–13). It appears from these figures that in this rodent body and tail are slightly longer in males than in females, while the reverse is true of hind foot and ear. It must be recalled that total length and tail are measured to end of caudal vertebrae, not to end of the long hairs which make up the prominent tail tuft.

A specimen (no. 12863, Field Mus.) taken by Edmund Heller at Furnace Creek Ranch April 26, 1903, became the type of *Dipodomys merriami mortivallis* (Elliot, Field Columbian Mus., zool. ser., vol. 3, December, 1903, p. 250). The chief character claimed for this supposed "new" subspecies was the "russet" color of the pigmented parts of the tail. This is exhibited likewise by those specimens in our present series that were taken on strongly alkali ground. This character is obviously adventitious; and the other features set forth by Elliot, as distinctive, do not prove to hold for specimens from the Death Valley region in comparison with long series from elsewhere on the deserts of southeastern California and southern Arizona (see Grinnell, Univ. Calif. Publ. Zool., vol. 24, 1922, p. 76).

### **Dipodomys deserti deserti** Stephens

Big Desert Kangaroo Rat

If one were choosing a wild mammal to point to as most characteristic of the below-sea-level portion of Death Valley, he would probably select, all things considered, the big desert kangaroo rat. Even though this rodent is strictly nocturnal in its activities aboveground, and to be seen ordinarily only at night when an individual may cross a road in the glare of an automobile's lights, the abundant "sign" left by it, and the association of this sign (the big burrow mouths and abundant foot and tail tracks) with the picturesque sand dune areas, at once attract the attention of the observant visitor. In structure so obviously specialized for existence amid just those conditions, it is not surprising that locally, as well as generally, this species is closely restricted in its occurrence to the areas where accumulations of wind-driven sand have reached considerable depths. Elsewhere it is present sparingly or not at all.

Especially in the northern "arm" of Death Valley, from the vicinity of the old road-crossing at Salt Creek northward past Triangle Spring, were conditions seemingly perfect for *Dipodomys deserti*. I guessed that the population over that area in April reached the figure of 128 adult individuals per square mile—on the basis of a pair to every ten acres; and in places the population density was evidently far greater. Burrows were not made in the areas of most rapidly shifting dunes. Rather, those dunes which were mesquite-crowned, therefore relatively permanent, even though low (say, down to two feet in depth of the sand upon the clayey substratum), were the ones selected mostly as burrow sites. Judging from footprints, easily to be traced after a spell of quiet weather, the cruising radius of an individual *deserti* in the course of a single night may reach an extent of hundreds of yards. The seed-product of large areas must thus become accessible to the animals from their localized safety-refuges.

In the vicinity of Furnace Creek Ranch, *deserti* lived on silty ground as well as where sandy. When dry, this clayey silt becomes flour-like almost, and hence easily diggable to an animal with weak powers of digging. But when wet, as when flooded after one of the rare downpours of rain, this type of soil "melts down" and must then become uninhabitable; the elevated and porous sand dunes then remain the strongholds of the "dipos", and the silty areas become re-inhabitable only as they again thoroughly dry out.

While typically an animal of quite open terrain (after the fashion of the jack rabbit), our trapping showed that *Dipodomys deserti* scouts out over all sorts of food-producing ground, even into the densest mesquite thickets. For example, an adult female that I trapped under a mesquite west of Furnace Creek Ranch, on April 12, 1917, was carrying in its cheek pouches many pieces of hardened sap ("gum arabic") which could have been gathered only from the mesquite trunks. However, this source must have been within reach of a position on the ground, as there is not the slightest evidence that "dipo" ever climbs.

As bringing out first-hand facts and inferences concerning the habits of the big desert kangaroo rat, I now quote from the field notes of Mrs. Grinnell and myself (dictating), set down at the time of observation. These are given almost verbatim—edited slightly, and with certain bracketed additions.

"7:00 a.m. [October 20, 1933]: Observing *Dipodomys deserti* burrows in lower slopes of rounded, rather permanent dunes of fine sand and silt, one mile west of Furnace Creek Ranch. These dunes are on the south side of the main lines of mesquite; hence they have been formed by winds blowing from the south gradually piling the sand and silt picked up from the open ground down the Valley and checked behind (that is, on the north sides of) some old outlying clumps of arrow-weed and small sized mesquite thickets. There is so much silt in the composition of the dunes that the rain has caked much of their surface, so as to render it semi-permanent; yet on the exposed sides (those especially toward the south) the wind has already etched into this 'caking,' and elsewhere there has been laid down a fresh layer of sand and silt in which the animal tracks show quite plainly. This is especially to be seen on the north sides of the dunes where the air currents are retarded. Here it is that the dipos have their burrows.

"The total height of the east-west line of dunes at this point, above base level, is about eight feet. The *deserti* burrows that we are examining are on the lower north slopes, all of them opening below the three-foot level; wherever there is a surface layer of newly sifted sand an abundance of tracks show, most conspicuously the sinuous tail tracks. Some of these, radiating from closed burrow mouths, are pretty nearly straight and continuous, up to a distance in one case, of 38 inches. Mostly, however, the tail tracks are intermittent, as if the animal were 'on the jump.' In one place a tail track meanders, with much side-to-side breadth at the short curves, as if the animal had been loitering along. Prints of the hind feet do not show so very clearly, because of their relatively great breadth. Also, the padded foot does not sink into this new veneer of loose sand. Each individual foot print is surprisingly wide, 18 to 20 millimeters across the toes in several measured. The heel rarely shows at all. Where clearly made out, hind footprints are side by side, though not always perfectly opposite with regard to the direction of movement; for example, in one pair, one print is 22 millimeters behind the other. Because of the multiplicity of tracks and their general indistinctness, I am unable to measure leap lengths. I am also not able to distinguish with certainty any track that I would ascribe to the front feet.

"Other animal tracks on the terrain under examination include those of desert quail, cottontail rabbit, and, under the edges of the mesquite, mouse (probably *Peromyscus eremicus*); and also of *Eleodes* beetles everywhere.

"The particular 'lay-out' we are planning to dig into consists on the surface, of four burrows, two of which are open and two closed—the latter plugged, it looks to me, from the inside. They are all on the lower north slope of the dune, opening thus to the northward; three are in line up-hill, 38 inches apart, and the fourth is the same distance off to the west of the uppermost one of the three, that is, on a level with it. At the front of each burrow mouth is a down-hill mound of spread-out sand and silt. The largest mound is in front of closed burrow mouth no. 3 (counting up-hill); it is approximately 3 feet long down-hill, by 2 feet wide. The surfaces of all the mounds are plentifully sprinkled with tail and hind-foot marks, showing use last night. The widths and heights of the burrow openings are: No. 1 (lowest, closed), 130 by 60 mm.; no. 2, open, 75 by 95 mm.; no. 3, closed, 110 by 85 mm.; no. 4, open, 65 by 70 mm. The latter has the most symmetrical, well-defined entrance of the four and may have been made last. I am assuming that the four burrow-mouths all belong to one rat. [The idea that there are 'colonies' of dipos may not be well-founded. Several entrances, or exits, to one burrow-system in a single large dune gives a first impression that there must be several rats concerned.]

"I begin digging with a shovel at the lowermost burrow, no. 1, at 7:45 a.m. The ground proves to be very soft, absolutely dry; it caves in very readily, the successive layers of caked dune surface breaking off freely. A cavity encountered 5 feet in from entrance no. 1 is 12 inches below the surface of the dune; diameter of cavity 200 mm. wide, 170 high; but parts of these dimensions are probably due to cave-in. Floor of cavity a mixture of sand, sections of mesquite pod, shreds of pod walls, and fresh and old leaves of mesquite. Some of this latter material is, however, just such as is included within the layers of which the dune is composed. Plugged segment encountered in no. 3, about 9 inches long.

"8:30 a.m. Baffled! Entrances 1, 2 and 3 found to join and lead off in irregular course, and with several loops, to a used entrance 12 feet to the east of, and on a level with, no. 1. Also, branches are numerous and in various directions, with some anastomosing. Farthest passages uncovered to south and southeast, 12 feet from entrance no. 1; south into dune, 9 feet. Estimated total length of burrow uncovered, 45 feet; but cave-in's undoubtedly meant my loss entirely of one or more passages. Greatest depth reached, about 2 feet; then face of cut would automatically cave in, because loose inter-cake layers of sand would run out until weight of caked layers overhead would make latter break off. This sort of process is continuous!

"Digging, for the rats, must be exceedingly easy. Indications are that dune to depth of 2 feet on north side has been pretty well honey-combed; probably earth moved back and forth repeatedly within system; indeed soft plugs often encountered, of sand intermixed with bits of mesquite pod (unripe when gathered); foecal pellets also mixed with sand here and there along passages. No special living compartment found, nor any trace of any nest. Only co-inhabitants found, a spider and a fish-tail [thysanuran ?].

"No rat showed itself. Some branches of the burrow-system came up to surface of dune at inconspicuous places, where ceiled over by most recent caking—possibly used as 'duck-outs'. Thus, *Dipodomys deserti*, here as elsewhere, appears to rely upon accumulations of exceedingly loose soil within which, with its limited digging powers, it can establish a labyrinth of burrows; in this labyrinth with connecting exits it can, as a rule, easily elude such digging enemies as the badger and coyote."

At Triangle Spring, on the morning of October 25, 1933, one of our quart-size, "live", can-traps produced an adult *Dipodomys deserti*. This we took with us on our hike to the sand dunes out in the middle of the valley. Quoting in essence: "We selected an area of about two acres of ripple-marked, freshly wind-laid sand, very gently undulating in relief pattern—most favorable for our purpose [of observing how dipo would behave when released upon it]. After release by Mrs. Grinnell out in the middle of this selected area [I with watch in hand near-by], in 42 seconds the rat had reached, and disappeared in, an arrow-weed clump which proved to be 76 paces away from point of release [my pace found to be 34¼ inches, heel to heel]. [This would be gross progress, then, at the rate of 5.2 feet per second, or but 3½ miles per hour.] The rat's course was not straight, but was somewhat meandering. Two or three times the rat stopped momentarily. It progressed by springy bounces, entirely on its hind legs. Tail, when animal was in motion, did not touch the ground, but was held a bit above horizontal, the end flopping up and down so that the white tuft was visible in up-and-down movement to the last.

"We were disappointed in the lack of speed shown; [after seeing what the 24-gram desert white-footed mouse could do] we were looking for prodigious leaps, rapidly executed [on the part of this 120-gram, specialized jumping rat]! *Possibly* this particular animal was confused by the glare, even though the sunlight was somewhat dimmed by cirrus clouds; or it might have been below par because of having been cooped up in the trap-can all or most of the night. Some measurements between foot prints, toe-tips to toe-tips, because these *dig in* on the harder sand surface: 380 mm., 590, 750, 710, 760, 540, 760. When under full gait, only the broad forward part of the foot leaves a track, involving the toes only—a roundish track; only when stopping does the hind foot clear to the heel show; also only then does any tail mark show.

"I then routed the rat out of its arrow-weed refuge, when it took to the open, I after it as if to catch it. He then went faster than I could run on the soft sand surface; now and then he resorted to quick side-to-side dodges that left me entirely at a disadvantage and out of breath. When *I* stopped *he* stopped, putting front feet to ground and also terminal half or so of tail. He then had five points of contact with the ground. To repeat, in locomotion the tail was held rather stiffly horizontal, or a bit above horizontal, the end bobbed up and down in unison with the bounces. The white tuft jerking up and down held the observer's eye. The animal, when no longer pursued, kept on, stopping now and then, until it took refuge in an arrow-weed thicket 100 yards or so off, where we left it in peace. I measured some more leap-lengths down a gentle slope off the edge of the sand patch: 670 mm., 620, 630, 670, etc.—pretty uniform.

"After the first 'heat' I was able to go back and check upon the tracks in the sand, these indicating 81 bounces in a distance of 55 of my own paces. [Calculated thus, the dipo when in full swing was progressing at an average rate of 23 inches per 'bounce'—which pretty closely accords with the measured distances, in millimeters, just given.] This rat, by daylight, showed no special concealing quality of coloration against the sand; it was quite visible even at rest, the big black eyes and white of feet and tail-tip being conspicuous. [The shadow that it cast, even though the sunlight was dull, added to its conspicuousness. Conditions at night, however, may make a very different impression upon a pursuer.]"

On the evening of April 21, 1917, Mr. Dixon spent some time attempting to get flashlight photographs of the big dipos west of Furnace Creek Ranch. He says: "They were out foraging by 8 o'clock, and I could hear them running about. At my approach they all ducked into their burrows, and I could hear a warning signal pass around the 'colony' under-ground. This warning signal was a sharp thumping sound similar to that made by a cottontail rabbit. This noise stopped after I remained quiet, but was renewed whenever I stirred." On April 23, Mr. Dixon's notes record further that "The flashlight was set up at a *deserti* hole in a sand dune where I had been feeding the rats rolled oats for a couple of nights. Although they had been taking this bait freely before, last night they refused to come anywhere near the burrow." Later, one individual became used to the presence of the camera and would come out

7 to 10 minutes after the apparatus was set up and the place left. The flash was sprung several successive times by this rat.

As to the breeding habits of *deserti* we learned little. A female trapped on April 8 contained one small embryo; two females taken on April 17 contained each two embryos. On April 13 the first young-of-the-year was trapped, this one weighing 52.5 grams, so less than half grown, yet foraging abroad. This animal must have been born back in mid-April.

Thirty-seven adult specimens were preserved from the floor of Death Valley. The 17 males gave weights, average and extremes, as follows: 116.1 grams (95.3–138.5); 20 females: 101.9 grams (82.8–118.5). The same two groups showed dimensions in millimeters as follows: Males, total length 348 (325–370), tail 201 (185–220), hind foot 54 (53–57), ear from crown 14.4 (13–16); females, total length 331 (304–377), tail 192 (155–211), hind foot 52.4 (48–55), ear from crown 13.8 (12–16). Differences between the sexes in these respects may thus often be rather noticeable; males average decidedly the larger.

As with *Dipodomys merriami*, individuals of *D. deserti* trapped on or closely adjacent to strongly alkaline ground, such as that at Triangle Spring, usually show a distinct reddish cast of color on the dorsal surface of the body, this reaching an extreme of rust-color on the normally blackish areas of the tail. Sometimes even the white "flag" terminating the tail is discolored with this rusty tone.

## **Onychomys torridus longicaudus** Merriam

### Long-tailed Grasshopper Mouse

Little was learned concerning grasshopper mice save as afforded by trapping them; and this did not disclose any distinctive "sign" of their presence, as compared with *Peromyscus*. The species was found only in the vicinity of Furnace Creek Ranch, perhaps simply because most trapping was done there. Getting an *Onychomys* in a night's trap-line was always considered merely a matter of luck. Kind of bait used did not seem to matter.

Of the total of thirteen individuals taken, one was on gravelly ground at a creosote bush, two were on silty, alkali ground down almost to the border of the "borax", −240 feet, where there was sparse arrow-weed, mesquite and salt-grass, and the rest (as far as notebook record shows) were on sandy or silty ground under mesquites. Thus, no narrowly restricted habitat preference was discerned. I suspected, however, that the metropolis of the species would be comprised in the gently sloping, flat terrain, of gravelly soil, where the creosote bushes grew of rather large size.

The thirteen specimens, of dates April 4 to 22, consisted of ten adult males, one immature male, and but two females, both adult.

It would look as though males are more venturesome or far-ranging than females, at least at this time in the annual cycle. A strong musky smell was given off by the dead males, even before handling in the process of skinning. This smell was different from that pertaining to white-footed mice or to wood rats.

The two females, taken April 20 and 21, 1917, each contained two large embryos. The small size of the litter thus indicated must be significant of a mode of existence that renders the individual *Onychomys* safer from the dangers that beset the more rapid breeding *Peromyscus.* The immature male was taken April 10, 1920; length 128 millimeters, weight 17 grams, pelage gray; possibly a month old, yet the testes were large.

The ten adult males weighed in grams, 18.6 to 22.9, averaging 20.6; the two pregnant females, 26 and 27 grams, respectively. As to dimensions, there seems to be no difference between the sexes. The twelve adults gave figures as follows: total length 140 millimeters (135–145), tail 50 (44–54), hind foot 20 (19–21), ear from crown 14.3 (13–15).

The adults are all bright-colored, the usual rather clear pinkish cinnamon characteristic of the race *longicaudus.* The brightest of the lot, in which this color tone may have been heightened by the extreme alkalinity of the surroundings, was taken April 22, 1917, nearest the borax flat, below Furnace Creek Ranch. In this one (no. 25932) the trend is strongly toward ochraceous-salmon (of Ridgway's Color Standards and Color Nomenclature, 1912, pl. XV).

## **Reithrodontomys megalotis megalotis** (Baird)

### Desert Harvest Mouse

Harvest mice were found only in the vicinity of permanent water, and where a hydrophytic growth of considerable extent exists. It is to be inferred that this type of environment, now restricted to a few relatively small and far-separated areas, must have been present continuously down through time since an era of much greater rainfall, when marshland or lush meadow was widespread and along the lowlands continuous. It would certainly be impossible for a harvest mouse long to survive exposure to open desert conditions in their extreme present-day manifestation.

To be more explicit, we found harvest mice in three places: Along Salt Creek in the growths of allenrolfea, tule and cane; at Eagle Borax Works, in the similar marsh-dependent kinds of plant growth there; and on Furnace Creek Ranch, along the irrigation ditches the banks of which were grown to lush vegetation inclusive of much bermuda grass. Regarding the latter locality, it must be remembered that the ranch lands were originally reclaimed from the dry desert by conducting the water down an open ditch from the original

Furnace Creek which was fed by the big permanent springs to the eastward, well above sea level. This was the condition when I was there in 1917 and 1920; but now the water is piped down. Riparian conditions were thus originally continuous down from the upland sources of the water to the ranch lands, and these are now (1933) being more and more extended—which means enlargement of the area occupiable by *Reithrodontomys*.

Such breeding data as was obtained from Death Valley was furnished by the mice trapped. On April 7, 1920, a female taken was found to contain five small embryos. On April 10, 1920, a young "reithro" was caught in one of Dr. Sumner's "live" traps; it was scarcely half grown, weighing but 5.2 grams. The above records were from Furnace Creek Ranch. At Salt Creek, on April 14, 1917, a female was found to contain three embryos; and at Eagle Borax Works, May 5, 1917, a female contained also three embryos.

Scrutiny of the tabulated measurements of the sixteen adult specimens of *Reithrodontomys megalotis* from Death Valley (12 males and 4 females) discloses no appreciable sexual differences. Therefore the figures, in millimeters, are given here in one summary, as follows (average, minimum and maximum): Total length 142 (132–152), tail 70 (60–78), hind foot 17.4 (17–18), ear from crown 12.1 (11–14). Weights range from 8.8 to 11.2 grams (both extremes are males), averaging for the sixteen, 10.2 grams. In color-tone of pelage the series is no paler than other population samples from the Mohave Desert and Great Basin; and curiously there is none of the supposedly alkali-caused discoloration that is shown by so many individual kangaroo rats and other dry-ground dwelling rodents.

### **Peromyscus crinitus stephensi** Mearns

Stephens Canyon Mouse

The presence of this mouse was detected at only one point in the below-sea-level portion of Death Valley, although the species was found commonly in the surrounding mountains. The reason for this general absence from the Valley floor is clearly that the inherent restriction of the species is sharply to the rocky gorge (cliff) type of habitat, and this type of habitat encroaches upon the valley bottom only along a small part of the "oo" contour.

On the evening of October 13, 1933, near Bad Water, −180 feet, Mrs. Grinnell and I put out 55 mouse and rat traps on all sorts of ground within easy walking distance of the road at the side of which on a gravelly wash-bottom we had camped. To us, fresh from Berkeley, the prospects of any returns at all were poor; we failed to see any rodent sign whatsoever, there were no traces of sand-dunes, vegetation of any sort was exceedingly meager, the heat, even after the shadows from the Panamints had finally overspread our side of the Valley, was oppressive; and this heat, especially the "glare" from the bare ground surface and from the cliff-faces close at hand, continued all night. Yet, in the morning we found in our traps no less than seven rodents, of two genera, *Neotoma* and *Peromyscus*, the latter of the species *crinitus* which was new to our Death Valley list. This was a 12 per cent yield, quite as good as the average a person obtains in far more promising sections of California!

The two wood rats taken, and one of the white-footed mice, were in traps in or near bouldery debris fallen from the cliffs of the Black Mountains; the mouse was in a trap under the edge of a large angular rock. The dominant (indeed, almost the only) plant in sight was the "desert holly" (*Atriplex hymenelytra*). But the astonishing thing was the capture of the other four *Peromyscus* in the 24 mouse traps we had set, "on a chance", out on the "self-rising" borax flat in some small tracts of low ink-weed bushes (*Allenrolfea*). These tracts were located 50 yards or so out on the forbiddingly rough "borax" ground, then dry and hard as rock. The traps were put in under the bushes where, however, no runways or other sign was seen even when we had learned the mice were there.

Upon reflection, the finding of this kind of *Peromyscus*, normally rock-inhabiting, in the ink-weed habitat in this particular place, is not difficult to explain. The rough, "self-rising" ground is full of crevices and holes, in this respect resembling the near-by steep mountain side, thereby meeting *that* requirement of *crinitus;* and the allenrolfea plants (absolutely the only kind of plant we could see out on the borax flat at this point) must through its seeds have provided the food. In a way, perhaps from a mouse's-eye view, the borax flat, when dry, *is* a cliff *prone*. This ink-weed population of *crinitus* we sampled, may thus be looked upon as an outlying, pioneer group—overflow from the near-by cliff habitat where conditions from the food-limitation standpoint must be severe.

Of the five specimens of *Peromyscus crinitus stephensi* taken, on October 14, 1933, all were preserved (nos. 61354-58). Four were males (all those caught under *Allenrolfea* bushes). None was sexually active, and the males were rather fat. Weights: ♀, 8.7 grams; ♂♂, 10.7 to 12.5, averaging 11.8 grams. In measurements, the ♀ gave figures as follows: Total length, 164 mm.; tail, 91; hind foot, 20; height of ear from crown, 15. The males averaged, same dimensions: 160, 85, 19.5, 16.2. Both as to skins and skulls these five specimens looked small as compared with series of the race *stephensi* from elsewhere in southeastern California. But condition of teeth shows that all were relatively young, probably born the preceding spring. That the four "pioneers" were thus all first-year males may have significance. One would suppose that in a period of very wet weather, the borax-flat population would be destroyed, and that reinvasion, when again possible, would be first, or farthest, by young males.

### **Peromyscus eremicus eremicus** (Baird)

Desert White-footed Mouse

The desert white-footed mouse was trapped, save on Furnace Creek Ranch proper, only on clayey or finely sandy ground beneath, or in the near vicinity of, mesquites. While its presence was detected by us only in the neighborhood of Furnace Creek Ranch and at Eagle Borax Works, it probably occurs also wherever the soil conditions stated, plus extensive growths of mesquites, occur. Arrow-weed, salt-grass, and other indicators of habitats for some other mammals, were believed to be only incidental for this one. *Eremicus* had invaded the cultivated ground of the Ranch and even entered the buildings and become "house mice" there, but not to the extent that *sonoriensis* had (see record of Dr. Sumner's trapping in April, 1920, in table p. 122); in or close about buildings, where a total of 96 *sonoriensis* were caught, 26 *eremicus* were taken.

This mouse is a climber, as witness the notes of Mr. Dixon, made at Eagle Borax Works, May 5, 1917: "I spent considerable time [last night] watching a pair of *Peromyscus eremicus* run up and down a large mesquite tree. The moon was full, so the light was good; the mice paid no attention to me as I lay in bed. They . . . ran fearlessly about, even on the smaller limbs no larger than a man's thumb. They gave a sharp 'rapping' signal, similar to that of *Dipodomys*, but I could not see how the sound was made." On April 11, 1920, Dr. Sumner trapped five *eremicus* on or under the roof of the (then) ranch house at Furnace Creek Ranch. No *sonoriensis* were taken so high up in buildings.

In October, 1933, Mrs. Grinnell and I ran some "live", can-type traps several nights in a tract of mesquite two miles south of Furnace Creek Ranch. We had been impressed by the speed of liberated individuals of *Peromyscus* in getting to cover, and we planned a way of measuring this speed. On the morning of the 17th a can-trap contained an *eremicus*. With the shovel, I smoothed an open level section of the silty ground, so as to provide a perfectly clean, dusty surface several feet square. With watch ready, the mouse was released from the can in the center of this area. In just 2 seconds he was out of sight in the adjacent mesquite thicket, having traversed in that time 3 feet of the specially smoothed space plus the additional 6 feet intervening toward the thicket. That equals 9 feet in two seconds, and he must have taken sufficient of this time to orient himself; for he followed the shortest route to the nearest edge of the cover! He had hit the ground on all fours (as shown by the tracks left in the dusty surface) 8 times in a distance of 6 feet 2 inches; the first three springs covered 14½, 14, and 16 inches, respectively, again as shown precisely by the 4 bunched footprints, the two in front (those of the hind feet) wider apart than those behind (of the front feet). To the human eye, his gait was a series of bounces almost too rapid to follow.

On the morning of October 21, we tried the same kind of experiment with two more can-trapped *eremicus.* This time, I prepared a smoothed area 8 feet or so square next to a mesquite. Mrs. Grinnell liberated the mice, one at a time, on the far side of this area from the nearest edge of the thicket. Mouse number one hit the ground 9 times, as shown by the dust-record left, in 3 seconds; intervals between heel marks: 18 inches, 13½, 9¾, 8½, 7¼, 7¾, 8¼, 8½, successively (equals a total of 81½ inches of distance covered in 3 seconds). This was a slower rate than that of the first mouse tried out. Such variations might be due to individual differences but also to greater amount of chilling after capture in the traps, of one mouse than another.

Mouse number two seemed more alert. When released it instantly took off, more to the right where a mesquite branch extended farthest toward it along the ground. He bounced 13, 25, and 18 inches, then off the smoothed area, having made a distance of 56 inches in approximately 1½ seconds.

Breeding data are as follows: Litter-size as indicated by embryo-records from mice collected in 1917, averages only 3; the figures for 12 pregnant females are: 4, 4, 3, 1, 4, 4, 3, 3, 3, 4, 2, 1. The dates of these records extend from April 4 to May 5. In 1920, Dr. Sumner's trapping produced 165 *eremicus,* of which 85 were males, 77 females; 80 were adult, 84 were juveniles (see p. 121). While these data indicate the main breeding period to be in the spring months, on October 19, 1933, I trapped a female under a woodpile at the Ranch, which contained 3 five-millimeter foetuses.

One of Dr. Sumner's papers is based importantly upon the stock of this mouse he obtained in Death Valley (Sumner, F. B., and Huestis, R. R., Studies of Coat-color and Foot Pigmentation in Subspecific Hybrids of *Peromyscus eremicus:* Biol. Bull., **48,** 1925, pp. 37-55).

A total of 32 specimens of *Peromyscus eremicus eremicus* are in the Museum's collection from Death Valley. The data accompanying those that were adult, taken April 4 to May 5, show weights of 14 males to average 24 grams, of 12 females 27 grams. Variation is great (18.4 to 39.5 in the males, 21.4 to 35.0 in the females). Degree of fatness in males, and stage of pregnancy in females, accounts for this variation, as also, doubtless, amount of food recently taken; for example, the stomach contents of one female weighing 32 grams were found alone to weigh 6.5 grams, or 20 per cent of the total weight. Measurements of 27 adults give averages in millimeters as follows: 15 males, total length 194, tail 99, hind foot 21, ear from crown 17; 12 females, same dimensions, 198, 102, 21, 17.

**Peromyscus maniculatus sonoriensis** (LeConte)

Sonora White-footed Mouse

The species *Peromyscus maniculatus* has been pointed to as the most widely distributed mammal in California; its range within this State extends through all the life-zones from Lower Sonoran to Arctic-Alpine, through all the faunal and subfaunal areas from most arid to most humid, and through nearly all the habitats to which, severally, many other rodent species are restricted. In other words, this white-footed mouse is tolerant of the widest gamut of physical and biotic conditions. Yet in Death Valley the species (in its race *sonoriensis*) does seem to find the limits of its tolerance in certain directions. For our trapping there has revealed its presence definitely in only five out of the eleven recognized habitats; it did not invade the dryest, truly "desert" parts of the area.

Specimens came to our traps, sparingly, at Triangle Spring and Eagle Borax Works, and more numerously on and around Furnace Creek Ranch. The native plants most constantly associated with the presence of *sonoriensis* were arrow-weed and salt-grass. Such other plants as mesquite, tule and ink-weed seemed likely incidental. The presence of ground moisture, or at least of more or less succulent vegetation, seemed requisite for this mouse. At Furnace Creek Ranch it was found everywhere on the cultivated lands, and along the "overflow" water courses westwardly down to the edge of the "borax" flat, altitude −240 feet (see table showing results of Dr. Sumner's trapping). It freely invaded the lower parts of ranch houses, and became the "house mouse" there. [No example of the true house mouse, *Mus musculus*, has yet been identified from Death Valley, to my knowledge.]

Dr. Sumner's trapping (see p. 121) was concentrated upon this rodent. A total of 773 trap-nights on and below Furnace Creek Ranch brought to his "live" traps 358 rodents. Of these, 168 were *Peromyscus maniculatus sonoriensis*, more than of any other species caught. This is not indicative of relative abundance, however, for it was this species that Dr. Sumner particularly wanted, alive, for experimental purposes and he adapted his efforts accordingly. Dr. Sumner's 168 *sonoriensis* were taken from April 5 to 14, 1920. Of these, exactly one-half were males, one-half females; 65 were definitely adult and 103 more or less immature. On April 14, a female with seven young was found in a nest in the superintendent's house. On April 19, 1917, a female weighing 31.5 grams and containing six large foetuses was trapped in the store-room at the Ranch. Three individuals taken at bases of arrow-weed clumps close to Triangle Spring, October 24 and 25, 1933, were in adult pelage and showed no sign of breeding. The breeding period of this species in Death Valley is thus indicated to be during the spring months.

Of the 8 specimens in the Museum's collection from Death Valley, one is a blue-pelaged juvenile (weight 9.1 grams), taken in the Ranch store-room, April 19, 1917. The other 7 specimens, including the female above referred to as pregnant, are in adult pelage. One of these was taken at Eagle Borax Works, May 7, 1917. This, and one other individual discarded, was trapped by Mr. Dixon on the swampy ground where tule, cane and mesquite grew abundantly. Weights of 3 males average 18.3 grams; of two non-pregnant females, 24.1. The measurements of 4 males and 3 females average: Total length 159 mm., tail 68, hind foot 20, ear from crown 16.

### **Neotoma lepida lepida** Thomas

Desert Wood Rat

The desert wood rat proved wide-spread in the Death Valley region. Its range extended to an altitude of 7500 feet on certain of the surrounding mountain masses; and on the floor of the Valley proper it was abundant in suitable places down nearly to the edges of the "borax" flat, close to −280 feet at Bad Water. We found its presence to be governed more by availability of shelter (stout-stemmed bushes or trees, and fractured rock outcrops or talus masses) than by any obvious vegetational factor having to do with food. In other words, *Neotoma* could use for food some, at least, of the kinds of plants present almost anywhere, provided shelter of a proper sort were at hand. True, it could dig, and thus supplement, by burrowing, the natural facilities for safety. But its own digging powers are weak, and only in silty or sandy ground could these suffice to help much toward security; indeed, these powers were evidently insufficient in themselves, without the defense provided by stout plant stems or by rocks, against digging carnivores. Another vital factor was shelter through the daytime, from the sunshine and extremest heat. Our observations showed the wood rats in Death Valley to be strictly nocturnal in time of their activity.

Considerable stretches of the Valley floor showed no sign of wood rats, these stretches comprising not only the lowest "self-rising" borax flat, but the wind-pavemented, open desert, marked only with sparse, small bushes, and also the nearly bare, broad, stony-surfaced wash-fans spreading down from the mountain canyons. But the tracts of mesquite, screw bean and arrow-weed, the gullied margins of ravine-cut mesas, and the steep-walled, rocky canyons wherever these invaded the area here under special consideration, were sure to disclose the presence of these rodents in greater or less numbers. Undoubtedly, the greatest concentration of numbers was where the stands of mesquite were closest and densest, as around Furnace Creek Ranch and Eagle Borax Works.

In the "Mesquite Arm" of Death Valley wood rats proved fairly common around Triangle Spring, there inhabiting the mesquite "crowns" of the sand dunes far out on the flat, the low patches of mesquites at the base of the low mesa, and the holes and cave-like chambers in the steep sides of the gullies and ravines which cut the margin of that mesa. Along Salt Creek the same kinds of habitat showed signs of wood rat, as also did some of the arrow-weed thickets which reach great size in certain places there. Where the Black Mountains rise cliff-like from the lowest part of the Valley, at Bad Water, sign was plentiful among the fallen rock masses at the base. The cliff-face above was honey-combed with cavities; hidey-holes of many calibers were plenteous. Here, on October 14, 1933, two wood rats were trapped, one of them among the rock debris, the other under a little bush of *Atriplex hymenelytra* growing on a little wash-fan out from the cliff-base a few yards. This was practically the only shrub in the vicinity and may be inferred to furnish the rats there with some of their food—along with whatever remains from the brief-lived "annual" herbage. Foraging at night to some distance (up to ten yards at least) over open ground, from their safety refuges, is thus indicated.

"Sign" of wood rats consists most prominently of the "houses", which are especially easy to see when beneath mesquites; for then they reach largest size, possibly because much building material is there available. These always, in our observation, rest on the ground; none was seen up in the branch-work, off the ground. Houses are conical accumulations of all sorts of removable objects: twig-ends, chunks of wood, mud-cakes, flakes of rock, dry cow and burro manure, and pods of mesquite and screw bean. One house consisted of clods of dried alkali mud, mixed with dry mesquite leaves and leaf-stems, and a few thorny cuttings.

Among rocks, the "houses" are represented by irregular accumulations of sticks and stones beneath and between them. Often such collections are meager, or else they can scarcely be seen because located far in under the boulders. Indeed, in places I have been able to see no trace of any accumulation. Then "sign" is restricted to the characteristic black (when fresh), elliptical fecal pellets, grouped, or piled in special spots under rocks, or scattered along regular routes of travel—these frequently recognizable as trails, because regular use has cleared the way of the finer surface material.

At night, the rats climb everywhere. They go all over the mesquite trees, despite the thorns, and they cut off the terminal twigs, doubtless for food. In places, the mesquite must provide the entire subsistence of *Neotoma*, both food and shelter; for example, in a tract two miles south of Furnace Creek Ranch where, in October, 1933, we could find no other vegetation seemingly within their cruising radius. Where the rats *were*, and mesquites were wanting, then the entire needs of these rodents were, of course, supplied from other sources. *Neotoma* is thus resourceful, compared with some mammalian species.

On the mornings of October 18 and 19, 1933, we selected one wood rat's "house" from the very many seen in the mesquite tract below (west of) Furnace Creek Ranch, for special examination. The selection of this house was made on the basis of its near maximum size, its accessibility to us, and because by clearing out some branches it could be photographed *in situ*. The following account, with very slight change in wording, is as written down by Mrs. Grinnell from my dictation, while I did the "dissecting".

The general site of this house is in a continuous east-west "line" of mesquites, one "unit" of which, the one immediately concerned, consists of eight large-sized trunks radiating from a center, which center presumably marks the union of these trunks below-ground where emanating from the main water-gathering root system far below. Only one of the trunks approaches vertical; one foot above the ground it is 40 inches in circumference. The rest of the trunks more or less approach horizontal position; at least some of their terminal branches lie on the ground. By estimate, the greatest height of this "unit" is 20 feet; its radius from the center, 25 feet.

Our wood rat's house is on the ground, due south of the center of the "unit". Its center is 12 feet from the center of the "unit". The house is built up so as to include within its mass a horizontal trunk (which is 4½ inches in diameter where it traverses the nest) together with a large number of smaller branches, the latter all dead. Also on the far side of the nest, and partly built into, is an old, long dead clump of arrow-weed, now consisting of a large mass of sticks, the longest broken-off tips of which, directed upwards, are about 5 feet long. Near the ground some of the sticks radiating slantingly from this arrow-weed clump reach a length of 6 feet.

The wood rat has thus insured well against successful ransacking of its house by a digging enemy, such as a coyote, in that the constituent materials are well reinforced by the anchored thorny branch-work of the tough mesquite and by the great number of sharp-pointed arrow-weed sticks constituting a sort of chevaux de frise on the peripheral side of the mesquite clump.

In looking about the vicinity and thinking of all the conditions to be met from a wood rat's point of view, with its limitations for getting away and the consequent necessity for a safety refuge and unassailable nursery, I could suggest no better place to have started this particular nest. The large size and clean symmetry of this house betokens, I judge, success in the accomplishment of these aims; no successful assault has yet been carried out against it.

That the wood rat at night climbs all over the mesquite branch-work overhead is indicated by cut ends of twigs as far aloft as I can see, up to a diameter of 3 millimeters each. All such twigs have been cut diagonally; the fresh ones show incisor marks. Cuttings of obviously this source enter into the composition of the nest. In the top are some fresh, green twig tips with leaves, some so fresh as likely to have been added last night. Such material is, however, in very small proportion to the entire mass, which to superficial examination consists basally of a very large mass of coarse sticks and sections of branches long weathered and broken to pieces by agencies other than the rats themselves, while toward the top of the house there is an almost pure constituency of the long, yellow mesquite pods, comprising by estimate a bushel (but see below).

The ground beneath our particular mesquite "unit" is centrally rather cleanly carpeted with dead mesquite leaves, fallen mesquite pods, and dead twigs and branches. Right around the house the ground is rather clean of bean pods and cut twigs, which makes it seem that the rat had used nearby materials first in accumulating the structural materials of its house.

It is probable that this house basally represents the work of several years and possibly of several successive tenants. But certainly all the great quantity of bean pods are of last summer's crop. It is assumed from evidence gathered elsewhere that only one adult rat is in residence at any one house at one time. There are near neighbors to this one; a much smaller house is ensconced in a tangle of arrow-weed and prone mesquite branches not more than 35 feet to the northward; and there are others a bit farther off up and down the mesquite "line."

The house we are examining is bluntly conical in lateral profile. On the ground it is 63 inches in diameter; its summit, the highest bean pods on it, is 27 inches above the ground level. Nine inches below the summit, following along the side of a sub-branch, is a well-defined entry-way, with rat feces showing among the bean pods on its floor. At lower levels, along the mesquite branches, there are openings of a diameter to admit free passage of a wood rat. Open-work construction is to be seen elsewhere also, though with no regularity of apertures.

We proceeded to pick bean pods from the wood rat's nest and to stack them on the clean ground near-by, working thus since 7:45. Save for broken fragments and for a few in interstices of the arrow-weed thicket, all are now (9:15) segregated. They constitute a pile as steeply conical as they will rest, 29 inches in diameter at base and 15 inches high to peak (straight up). There is no evidence of an older crop of beans in the nest, and the present, bright yellow, this year's crop, has been taken by us from the surface and the upper fourth of the peak of the nest, where more or less mixed with sticks, cakes of dried surface-mud, and an occasional burro dropping. The basal half of the "house" still remains, with at least four holes (passages) entering it. We have a stack of sticks, separately removed to one side, higher than the house now is, and also a separate pile of the mud cakes.

9:35: Just finished counting the entire number of "beans", doing so by counting them out into piles of 100 pods each. Result, 29 stacks, plus 63 pods: total, 2963 pods.

Very few bean pods still hang in position on the mesquite branches; this year's crop has almost all fallen and it litters the ground picturesquely beneath those clumps which bore heavily this year; in following the mesquite "lines" it is clear that production of beans was not uniform; some "units" bore much more heavily than others. The heaviest crops we have seen have been under the lines of mesquites down west of the ranch, where presumably best watered subterraneously.

The great majority of pods from the wood rat house are entire; perhaps one in twenty has been split and the "beans" within split and the kernels removed. (This is not quite correct, since the seed proper is inside a capsule which is part of the pod, with the sweetish pith between this capsule and the outer wall of the pod.) Very many of the pods have little holes in them, each about one millimeter in diameter, made by a pea-weevil (*Bruchus* sp.). Adults of this beetle lay eggs in the flowers at the time the seeds are "setting"; the new insects, when mature, emerge, each through the little round hole, when the pods are ripe and dry. Such holes penetrate to the seed proper and may be scattered along a given pod to the number of 16 in a pod of 188 mm. chord. All the pods, be it noted, are more or less curved, varying from a slight crescent to the shape of a capital C, even to a complete circle, with spiral trend. Diameter of one of the latter in hand is 50 mm. Some slightly curved pods are: 162, 141, 149, 148, 172, 159 mm., respectively, in chord.

The mesquite pods are now rigidly dry, strong, break brittly under lateral pressure. The nutriment in them is the sugary pith within the substance of the pod. The seed proper, of which there may be as many as 24 in one pod, and its capsule, comprised in the innermost layers of the pod, are exceedingly hard, at least in the fully-ripened pods. I see an occasional split pod, evidently gathered before ripe, in which the capsules have been split and the seeds themselves removed.

Two hundred forty-seven mud cakes, by count, were taken from the upper structure of the nest and very many more remain *in situ*. Continuing with the demolition of the house: Entrances near the ground lead to considerable cavities along which are many more mesquite beans and also mid-ribs of green leaves, this material mixed with fecal pellets. Ensconced at the base of the arrow-weed clump, best protected perhaps of any part of the whole structure, is a cavity 140 mm. high by 190 mm. wide. The walls of this cavity are kept from caving in by the arrow-weed stalks which extend out through the surrounding mass. In the bottom of this cavity is a very neat nest whose concavity opens up diagonally and is symmetrically rounded—108 mm. deep and 68 mm. in diameter. The wall of this nest, about 25 mm. thick, is loosely felted, "pure culture", finely shredded inner bark of dead mesquite, such as we find on the smaller branches an inch or less in diameter. This material has a very soft texture; it is perfectly dry and absolutely clean of any excrementitious material.

Further demolition uncovers hundreds more mesquite pods! In the lower levels some of them were evidently gathered green and are still green in color. Further galleries are uncovered, communicating with the nest chamber already described; and there are holes into the ground at the base of the arrow-weed clump. We have seen nothing of the rat; it evidently has made use of avenues of escape beyond our reach or notice.

We have saved, for the Museum, samples of mesquite pods, mud cakes, and nest lining. Among the pods are samples of various sizes and shapes; ripe ones and ones evidently picked green; some "split" and some evidently gnawed into after dry and hard, seemingly just for the sugary pith.

Elsewhere a small wood rat's nest was seen with a few screw-bean pods, or clusters of pods, at its summit—no mesquite pods, as apparently none was available near-by.

On October 28, in the same neighborhood, we selected another wood rat house for dissection. This one was in the periphery of one of the "units" of an old row of mesquites; it was 17½ feet west of the main stem of the unit. This stem was one of the biggest in the line and its crown topped the line for some distance either way. The main trunk was 55 inches in circumference one foot above the ground. The height of the house was 22 inches; its diameter, lengthwise of the protecting mesquite branches, was 42 inches; diameter at right angles to this, 35 inches. The prone, main mesquite branch, at the edge of the nest toward the center of the unit, had a diameter of 4¾ inches; it was alive and it branched repeatedly, one set of branches extending up over the peak of the house, and other branches (part of them dead) traversing the mass of the house. The latter was thus effectively reinforced against being dug to pieces.

The upper part of the house (fully the upper half in altitude) consisted almost purely of mesquite pods; only a few sticks were mixed in. A hole at the level of the ground entered the mass just beneath one branch and parallel to it. There were other openings on the opposite side among the emerging branchlets. We found that the pods, despite their "pure culture" at the peak, could not be lifted off en masse; they clung together and to the penetrating mesquite branches like jackstraws because of their interlocking curvatures. So we laboriously picked them out, forming, apart, a steep-sided heap 20 inches high. We then counted them out into separate piles of 100 each; results, 36 piles plus 83 pods—or a total of 3683 pods, in this one house! We found them intermixed into the base clear to the ground level; indeed, over half the total bulk of the house appeared to consist of pods! Further dissection showed not a trace of lined nest above-ground; but holes went down into the soft, silty earth. We did not follow them.

The superintendent of the ranch told me of "rats and mice" about the buildings and haystacks. On the chance that we might find real house mice and house rats here, thus species new to the mammal fauna of the Valley, on the evening of October 18 we put out 41 traps—in a grain shed, in the blacksmith shop, in garages, and under the edges of big haystacks margined by horse and cow corrals. Results: Desert wood rat (adult male in grain shed); *Peromyscus eremicus* (adult male under pile of fence posts within ten feet of haystack). Thus neither "rat" nor "mouse" was of a non-native species. Maybe the latter, even having gotten here, would be unable to survive the summer temperatures, even at night, under which they would have to forage abroad.

No indication of breeding activity on the part of *Neotoma* was found in October; but in April the specimens taken, and all other sources of information in this regard, showed that the annual reproductive program was then about at its peak. A female taken April 21 (1917) contained one embryo; one taken April 24 contained two embryos, as did also one taken April 25; one taken April 11 contained three embryos, as also did two females taken April 20 and one taken May 7. On April 8, 9 and 10 (1917 and 1920), young animals weighing but 33, 32 and 30 grams, respectively, were caught in traps, betokening an unexpected degree of precocity, as well as earliest dates of birth. On May 2, a nest was found containing three young wood rats, well covered with hair but eyes not yet open. The mother had been caught previously and the nest and young were located by the collector's hearing the hungry squeaking of the latter, one of which in crawling about had gotten out of the nest and into the entrance burrow. The nest proper, under a buried mesquite limb, beneath a house and 10 inches below the surface of the surrounding ground, was about "8 by 10 inches" in diameter, with walls 2 inches thick; the component material was entirely of shredded inner bark of mesquite.

The small size of the litter shown by these data (one to three, averaging 2½) would seem to indicate relative individual "security" of these Death Valley wood rats. However, we do not definitely know that more than one litter is not born per year; the series of specimens taken does show, though, that none is born before April —and this despite the long period of warmth correlated with low altitude and other physical factors. The wood rats have "biotic controls" upon their numbers in the forms especially of wildcats and coyotes, tracks of which, in 1917, were seen plentifully in the dry silt along the burro trails around and through the mesquite tracts west of Furnace Creek Ranch. A Cooper hawk (*Accipiter cooperii*) I shot there on the morning of April 19 contained in its crop considerable portions of an adult male wood rat. Rattlesnakes were known then to inhabit those mesquite tracts; and in October, 1933, a great horned owl, well known as a wood-rat-catching species, was flushed from them.

Of 42 mature specimens of *Neotoma lepida* preserved from the below-sea-level portion of Death Valley, 16 are males and 26 are females. These provide measurements as follows, in millimeters (average, minimum and maximum). Males, total length 302 (270–337), tail 129 (115–148), hind foot 31.7 (30–35), ear from crown

25.6 (22–31); females, total length 295 (270–315), tail 128 (118–145), hind foot 30.5 (29–33), ear from crown 25.5 (21–31). Weights of the same groups are, in grams, as follows: Males 159 (112–201); females 137 (108.3–178).

The type specimen of C. Hart Merriam's *Neotoma desertorum* was taken at Furnace Creek [Ranch], by T. S. Palmer, January 31, 1891 (Merriam, Proc. Biol. Soc. Wash., vol. 9, July 2, 1894, p. 125). This name stood for many years as the name to use for the desert wood rat, until the older name, *lepida*, was brought forward (Goldman, Journ. Mammalogy, vol. 13, 1932, pp. 59ff).

## **Lepus californicus deserticola** Mearns

### Desert Jack Rabbit

The jack rabbit was present far and wide on the floor of Death Valley, both up the rock-strewn wash-fans and down on the lowest alkali reaches just short of the "self-rising" ground. For example, on April 10, 1920, I saw "sign" about some wisps of salt-grass at the very edge of the "borax", −280 feet, west of Furnace Creek Ranch. The rabbits were more numerous in 1933 than they were in 1920 or in 1917; yet their numbers never reached those commonly met with on the Mohave Desert. Never in Death Valley did I "jump" more than one individual in one day; and on many days none would be "checked" on a 2 to 4 hour tramp, even though "sign", more or less fresh, could be found wherever specially looked for.

Activity, in foraging, was clearly altogether at night. The animals occupied "forms" during the day-time. One such, near Triangle Spring, was in (beneath) a clump of the tall bunch-grass there ("sacaton"). Another, from which a jack rabbit was jumped in the forenoon of April 16, 1917, was beneath an allenrolfea bush affording rather scant shade. This was a suckling female; search far and wide failed to disclose any young.

I found no evidence that jack rabbits visit water to drink; presence in the vicinity of springs was merely due to the forage available there. Salt-grass appeared to be the "staff of life." The sacaton, prevalent in tracts in the vicinity of Salt Creek, Triangle Spring and Surveyors Well, was in October, 1933, seeding abundantly. The clumps of tall filmy seed-stalks, where these clumps grew close together, then lent a distant appearance of yellow, ripening grain fields. The rabbits were eating this grass freely, but not the blades and not the seed-heads, only the stems bearing the seeds. Moreover, certain clumps would be chosen, and very many others in the near vicinity apparently not touched at all. This was shown by the circle of droppings and cuttings about a selected clump.

On October 29, up Furnace Creek Wash, we saw where a jack rabbit had cut off the terminal leafy twigs from a creosote bush

(*Covillea*). We wondered if this bitter "greasewood" was actually eaten by a rabbit. Even burros, as far as I know, do not touch it!

One specimen of *Lepus californicus deserticola* was preserved, an adult female shot near Triangle Spring, April 16, 1917; weight 2086 grams (about 4½ pounds); dimensions: total length 552 mm., tail 95, hind foot 120, ear from crown 158. The pelage dorsally has the "singed" and faded-to-brownish sub-surface color tone in more extreme degree than specimens of nearly the same date from elsewhere on the deserts of the Southwest.

## **Sylvilagus audubonii arizonae** (J. A. Allen)

### Arizona Cottontail

Judging from my observations in Death Valley, the entire fortunes of the cottontail rabbits there are bound up with the mesquite: no cottontail, nor sign of any, was seen elsewhere than in the immediate vicinity of tracts or at least heavy clumps of the mesquite. Other shrubby growths, such as of arrow-weed and atriplex, were used on occasion by the rabbits for safety refuge or daytime cover; but it was the mesquite that furnished the final line of defense against pursuing enemies, as also the main source of food.

Cottontails were unexpectedly active in the daylight hours; only during midday, from 9 or 10 o'clock until 4 or 5, did they keep entirely out of sight. This was not merely a matter of "jumping" them: the observer would see individuals at considerable distance in the hot sunshine crossing open spaces between thickets. For example, a pencil census taken on October 21, west of Furnace Creek Ranch, from 7:40 to 10:30 a.m., included 5 cottontails seen. On the early morning of April 5, 1917, I counted 10 cottontails during the rounds of my trap-line west of the Ranch; and nearly all of these were sighted out of shotgun range. They were certainly keen of hearing as well as of eyesight; I thought at the time that the extra large ears seemingly characterizing the population in Death Valley, might be correlated with the greater distances apart there of the tracts of mesquites, which followed, apart from one another, the routes of underground water courses down toward the borax flat. However that may be, each rabbit, whether under cover or in the open, seemed always fully aware of *my* presence by the time I had caught sight of *it!*

As for possible water-requirement, no definite evidence was forthcoming that any of the rabbits in Death Valley sought water to drink. Cottontails were present in the vicinity of Salt Creek, but as far as shown by the "sign" they did not go out into the ink-weed or cane habitats, where the salt and alkali saturated water flowed. Nor were they seen more frequently near the overflow streams of relatively "fresh" irrigation water west of Furnace Creek Ranch than two miles south of the Ranch, where there was no trace of surface water.

On October 15 and 17, 1933, in the latter locality, we were struck by the complete dependence of the cottontails on the mesquites. These here grew in great flattened masses. The preponderance of any one mass lay close to the ground; indeed, from the center all the major stems of a mass would radiate 10 to 25 feet, prone or resting at least in part upon the ground. This habit of growth brought the minor branches and twigs and much of the leafage within reach of such a non-climbing mammal as *Sylvilagus;* and, in truth, I found very much cutting of twigs up to 2 or 3 millimeters in diameter at this low level (up to 15 inches above the ground—the "reaching" height of a rabbit). That this low-level work was that of *Sylvilagus* and not of *Neotoma* was shown by the abundant droppings of the former strewn over the ground beneath. The cut ends of the stems were mostly on a 45° "bevel". Old stems were "pollarded"; that is, a clump of new shoots and (or) leaves had sprung forth just short of the previously cut ends, and these in turn had often been browsed: the evidence showed that crop after crop of this rabbit-food had been produced!

We set large-sized rat traps on the ground beneath and amid the prostrate mesquite branches, and in the morning found in them within fifty feet of one another two male cottontails. Each, upon being "put up", was found to have some fat next to the skin; their physical condition was excellent. In each instance the rabbit was caught by its head; it had been attracted, at least for the moment, by the bait, which was scattered rolled oats, with dried apricot and prune adhering to the treadles of the traps. The finely silty, almost floury, soil in this vicinity supported at this time no other plant growth, beside the mesquite, than the arrow-weed; and I saw no indication that the cottontails ever draw upon this latter plant in any degree whatsoever for food.

In April (but not in October), breeding was in full sway. No actual nest was found. But a litter of three, or possibly more, small young on Furnace Creek Ranch had its home under a pile of mesquite wood. One of these met its death, on April 8, 1917, by drowning in a near-by irrigation ditch. This one, although thus already venturesome, weighed only 41 grams—scarcely one-sixteenth the mass of an adult. Another from the same litter, shot on April 20, had reached a weight of 243 grams, over a third the mass of an adult. Growth is rapid! On April 3 a female shot was found to contain 3 foetuses each two inches long; on April 5, a female taken contained 4 embryos; on April 17, 1920, a female shot but not preserved as a specimen was found to contain 6 small embryos. A rather high rate of reproduction is thus indicated. The fact that in 1933 the cottontails were fully as abundant as in 1917, shows perhaps that the decrease apparent in natural enemies (wildcats and coyotes) had not been any more than balanced by the levy upon their numbers by the increasing numbers of human hunters—who were still active, since full protection of the native animal life in Death Valley had not yet been enforced.

Nine adult cottontails, 6 of them males and 3 females, gave average measurements as follows: Total length 345 mm., tail 45, hind foot 83, ear from crown 93. Their weights averaged 685 grams (1½ pounds); extremes, 571 (a male) and 872 grams (a pregnant female). The Death Valley specimens have larger ears than specimens of the same species from the Mohave Desert proper. Also the tone of color in fresh-pelaged, October-taken examples is paler dorsally—ashier on the sides and rump. But these differences are slight, and in view of the geographic variation observable in populations here and there throughout the general range of the race *arizonae*, do not warrant the use of a separate name for them—*rufipes* of Elliot (Field Columb. Mus., zool. ser., **3**, December, 1903, p. 254); type (no. 12631, Field Mus.) taken by Edmund Heller at Furnace Creek Ranch, April 28, 1903. Data as to type specimen in this and other instances were furnished me through the kindness of Mr. Colin C. Sanborn, Assistant Curator of Mammals at the Field Museum of Natural History, Chicago.

## **Ovis canadensis nelsoni** Merriam

### Desert Bighorn

The Desert Bighorn or Mountain Sheep is, interestingly, the only native ungulate mammal known to occur in the immediate neighborhood of Death Valley. Neither deer nor antelope have ever been reported authoritatively, to my knowledge, from anywhere in the surrounding mountain ranges, let alone from the Valley itself. The Desert Bighorns, however, evidently find in this region about the optimum conditions for their existence, and they remain [in 1933], as they doubtless have been for long aeons, about as numerous as the limits of subsistence at the periods of least food-supply allow. They can forage over practically the entire region despite its roughness; by reason of their superb climbing ability they get to the sparse vegetation they depend upon, in the remotest places, and still are within reach of springs or "tanks". For we know these animals must drink at intervals depending in number of days upon the season of the year and the succulence of the plant food available to them.

As for the below-sea-level floor of Death Valley, we know from a consensus of testimony that, although sheep as a rule avoid remaining long on flat, open ground, even the "self-rising" mid-portion of the Valley is occasionally crossed by them. For example, Mr. Monroe Wagnon, who had prospected in the vicinity off and on for ten years, told me in October, 1933, that sheep frequently go back and forth across the "Devil's Golf Course" between the Black

Mountains and the Panamints. He has seen them himself and they showed no special difficulty in negotiating the rough ground. They go in the day-time and mostly in summer. He thinks this movement is caused by desire for new forage or "change of feed", coupled with disappearance of water in the rain-filled "tanks" in the Black Mountains. There are stated to be no permanent springs in the northern section of this range. So late as December or January (1932-33) a truck-driver told Mr. Wagnon of nine sheep seen by him on the floor of the Valley south of Furnace Creek Ranch, thought to have been crossing over from the Panamints to the Black Mountains.

Supporting the above ideas in a general way, was the finding by Mrs. Grinnell and me, on October 14, 1933, of a weathered fragment of the skull of a bighorn among the rocks of a talus at the foot of the steep face of the Black Mountains close to "Bad Water" of the U.S.G.S. map. This specimen (now no. 61368, Mus. Vert. Zool.) consists of part of the cranium, with one horn-core, of a young ewe. The altitude of this find was close to −280 feet. There was nothing to indicate how the animal met its death; possibly it had been shot on the cliff-side above.

While, to repeat, bighorns occur on all the ranges around Death Valley, the greatest numbers exist on the Panamint Mountains. This was stated to me in the different years of my visits by a number of persons acquainted with the region. The latest word, that of Mr. Wagnon, above cited, was that "quite recently" he himself had seen 80 sheep in one band in those mountains. He believes they are "on the increase." A few may still be killed by Indians, but the old-time "jerky-hunter" has gone out of business. Perhaps the only non-human restrictive factor in this region is the Golden Eagle. Mr. Wagnon once found a cliff-side nest of this bird within a few miles of Ryan, about which were the remains of several lambs. But eagles are rare in this country; and anyway what they do does not affect the total sheep population, since it is a perfectly normal factor.

Interesting from the nomenclatural standpoint is the fact that the type of C. Hart Merriam's *Ovis nelsoni* was shot June 4, 1891, by the late Edward W. Nelson at a point on the Grapevine Mountains about ten miles due north of Surveyors Well. More exactly, as later stated to me by Dr. Nelson (letter of March 3, 1917, in files of Mus. Vert. Zool.), this was on "the high limestone ridge forming the middle of the range, about five miles southerly from Grapevine Peak . . . . At the time these sheep were taken, we were camping at Bighorn Spring, in a canyon in the midst of the range".

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**No. 10**

# A NEW MARINE TURTLE FROM THE MIOCENE OF CALIFORNIA*

BY

CHARLES W. GILMORE

*Curator of Vertebrate Paleontology*
*U. S. National Museum*

In a collection of pelagic mammal remains, transmitted to Dr. Remington Kellogg for study and description by the California Academy of Sciences, was the right femur of a very large marine turtle. This specimen is of unique interest as being the first recognizable bone of an extinct cheloniid to be found on the west coast of North America.

Comparisons made of this bone with the femora of extant sea turtles show its closest resemblances to be with the green turtle (*Chelonia mydas*), and yet it differs sufficiently to indicate the possibility of its affinities falling outside of that genus when materials are available for adequate study.

A review of the extinct Cheloniidae shows that of the several genera and species assigned to this family all are based upon very fragmentary specimens, and in nearly every case doubt is expressed as to the validity of the family assignment. Furthermore, with none of these type specimens is there a femur preserved, which precludes the possibility of determining the relationships of the California specimen with extinct forms.

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December 30, 1937

The genus *Procolpochelys*, established by Hay[1] on Leidy's species *Chelonia grandaeva*, is from the Miocene of New Jersey, and Case[2] has assigned fragmentary specimens from the Miocene of Maryland to the genus *Chelonia*. These together with the large leatherback, *Psephophorus calvertensis* Palmer,[3] also from the Maryland Miocene constitutes all the recorded occurrences of marine turtles in the North American Miocene.

In view of the meagerness of our knowledge concerning the marine turtles of the Miocene, and the unique geographical occurrence of the California specimen, I propose the new species *californiensis* for its reception, and shall provisionally assign it to the genus *Chelonia* until the discovery of more adequate materials may permit the determination of its true affinities.

### **Chelonia** (?) **californiensis** Gilmore, new species

Plate 14, figures 1, 6

*Holotype:* No. 4,379, Mus. Calif. Acad. Sci., Paleo. Type Coll., from **Sharktooth Hill,** Sec. 25, T. 28 S., R. 28 E., M.D.M., **Kern County, California;** collected by Charles Morrice, 1924; Temblor formation, middle Miocene.

The large size of the type femur at once distinguishes this species from all living members of the family. In size it rivals *Dermochelys coriacea* the largest of living turtles, some of which reach a length of nearly nine feet. A specimen in the California Academy of Sciences, measured by Joseph R. Slevin, is eight feet, eight inches long, the same across the spread of the flippers, and weighed 1286 pounds; it was taken off Santa Cruz, California, June 23, 1924.

The largest available femur of *Dermochelys* (pl. 14, figs. 2, 7) in the National Museum collections has a length of seven and three-quarter inches, whereas this fossil femur measures nine and one-quarter inches. The ends are robust and expanded; the distal end being especially stout. The head is strongly developed, but it lacks the globular symmetry of the living sea turtles. In a prone position on the posterior side the head is inclined inward from the perpendicular, whereas in *Dermochelys*, *Caretta*, *Colpochelys* and *Chelonia mydas* (pl. 14, figs. 2-5) it stands erect. The femur is but little bent, and the distal articular end looks more backward than downward

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[1] Fossil Turtles of North America, 1908, p. 215.

[2] Miocene volume, Md. Geol. Survey, 1904, p. 64, pl. 26, fig. 5.

[3] Proc. U. S. Nat. Museum, vol. 36, 1909, pp. 369–373, pl. 31.

when the bone is in its natural position. The greater trochanter is strongly developed and its upper extremity rises above the level of the head as it does in *Caretta* and *Chelonia*. (pl. 14, fig. 1). In *Dermochelys* and *Colpochelys* (pl. 14, figs. 2, 4), however, they are subequal in height. The intertrochanteric fossa is relatively deep. Viewed from the posterior side, (pl. 14, fig. 6) it will be observed that the highest point on the proximal end comes on the median axis of the bone, a feature that at once distinguishes the femur of *Chelonia* from those of *Caretta* and *Dermochelys* (pl. 14, figs. 7, 8) which have the highest extension of this end on the external side.

The shaft is constricted at the middle of its length which measures 55 mm. in transverse diameter. The total length measured parallel with the axis of the bone is 243 mm. Through the head and the trochanter the distance is 112 mm., through the distal end at the center 78 mm. The least diameter of the shaft is 42 mm., and the greatest transverse diameters of the two ends is: proximal 101 mm., distal 120 mm.

## Plate 14

Figures 1–5. Comparative views of turtle femora as seen from above. Slightly more than one-fourth natural size.

Fig. 1. *Chelonia* (?) *californiensis* Gilmore, new species. Holotype No. 4,379, Mus. C.A.S., Paleo. Type Coll., from Sharktooth Hill, Sec. 25, T. 28S., R 28E., M.D.M., Kern County, California.

Fig. 2. *Dermochelys coriacea* (Linné); No. 29,492, U. S. Nat. Mus.

Fig. 3. *Caretta caretta* (Linné); No. 62,754, U. S. Nat. Mus.

Fig. 4. *Colpochelys* sp.; No. 29,015, U. S. Nat. Mus.

Fig. 5. *Chelonia mydas* (Linné); No. 29,342, U. S. Nat. Mus.

Figures 6–10. Comparative views of turtle femora as seen from below. Slightly more than one-fourth natural size.

Fig. 6. *Chelonia* (?) *californiensis* Gilmore, new species. Holotype No. 4,379, Mus. C.A.S., Paleo. Type Coll., from Sharktooth Hill, Sec. 25, T. 28S., R. 28E., M.D.M., Kern County, California.

Fig. 7. *Dermochelys coriacea* (Linné); No. 29,492, U. S. Nat. Mus.

Fig. 8. *Caretta caretta* (Linné); No. 62,754, U. S. Nat. Mus.

Fig. 9. *Colpochelys* sp.; No. 29,015, U. S. Nat. Mus.

Fig. 10. *Chelonia mydas* (Linné); No. 29,342, U. S. Nat. Mus.


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## No. 11

# CONTRIBUTIONS TO ORIENTAL HERPETOLOGY*

## V. HONSHU OR HONDO, THE NEIGHBORING ISLANDS OF SADO AND AWAJI, AND THE SEVEN ISLANDS OF IDZU

BY

JOSEPH R. SLEVIN
*Curator, Department of Herpetology*
*California Academy of Sciences*

The material at hand in our collections from Japan shows Honshu or Hondo Island, the largest island of Japan proper, to be inhabited by most of the species represented from the other islands constituting the Japanese Empire, and to have a fauna closely related to certain species found on the opposite mainland.

All of the species found on Sado and Awaji islands are represented in our collections by specimens from Hondo, while *Eumeces latiscutatus okadæ* seems to be confined to the Seven Islands of Idzu.

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December 30, 1937

## HONDO ISLAND

### 1. **Triturus pyrrhogaster** (Boie)

Our collection includes a large series of specimens of this salamander from the following localities:

16022 to 16037. Kobe, Settsu Province, Sept. 24, 1906.
16324 to 16327. Yura, Tango Province, Sept. 20, 1908.
16328 to 16340. Miyazu, Tango Province, Oct. 1908.
25116 to 25123. Ichinoseki, Rikuchu Province, 1910.
25124 to 25127. Yamashiro, Kaga Province, 1910.
25128 to 25132. Mimaya, Rikuoku Province, 1910.
25133. Nakayama, Rikuoku Province, 1910.
25134 to 25137. Inawashiro, Iwashiro Province, 1910.
25138 to 25140. Ina, Rikuoku Province, 1910.
25958 to 25966. Kawabe, Rikuoku Province, 1910.
26717 to 26722. Sekiya, Himotsuke Province, 1910.
33044. Kobe, Settsu Province, May 3, 1911.

### 2. **Megalobatrachus japonicus** (Temminck)

A single specimen (No. 16016) was collected in Mimasaka Province, Sept. 20, 1905. A large skeleton (No. 39684) is labeled merely Japan.

### 3. **Hynobius lichenatus** Boulenger

Dunn has studied our salamanders of the family Hynobiidæ and has referred to this species more than thirty specimens, as follows:

26716. A larva from Mimaya, Rikuoku Province, 1910.
26708. A larva from Ozorezan, Rikuoku Province, 1910.
25630 to 25749. Larvæ from Shiogama, Rikuzen Province, 1910.
26685 to 26707. Adult specimens from Inawashiro, Iwashiro Province, 1910.
16019 to 16020. Hakone, Idzu Province.

These specimens are called *Hynobius peropus* by Dunn (Proc. Amer. Acad. Arts and Sci., Vol. 58, No. 13, pp. 445–523, June, 1923).

### 4. **Hynobius naevius** (Schlegel)

Two cotypes from the original series (Nos. 64467, 64468) are listed here, although it is not positively known that they came from this island, the type locality being stated as the mountainous parts of Hondo and Shikoku.

### 5. **Hynobius kimurai** Dunn

Two larvæ (Nos. 16322, 16323) from Miyazu, Tango Province, 1906, and one grown specimen (No. 27258) from Hida Province are referred to this species by Dunn.

### 6. **Hynobius vandenburghi** Dunn

Represented by five specimens as follows:

The type (No. 26714), an adult male, collected at Nara, Yamato Province, May 1907.

Three (Nos. 25948 to 25950) from central Hondo.

One (No. 35931) labeled merely Japan.

### 7. **Pachypalaminus boulengeri** Thompson

This species is represented by the type specimen only (No. 33192), collected at Odaigahara Mountain, Yamato Province.

### 8. **Onychodactylus japonicus** (Houttuyn)

All our specimens were collected in Honshu, as follows:

| | |
|---|---|
| 16017 and 16018. | Hakone Lake, Sagami Province. |
| 16021. | Yokohama, Musashi Province. |
| 25142 to 25481. | Mimaya, Rikuoku Province, 1910. |
| 25482 to 25629. | SE. Osorezan, Rikuoku Province, 1910. |
| 26709 to 26713. | Sawatari, Kotsuke Province, 1910. |
| 26715. | Mimaya, Rikuoku Province, 1910. |
| 49145 and 49146. | Osoresan, Rikuoku Province. |

### 9. **Bufo vulgaris japonicus** Schlegel

The large series of toads now at hand tends to show that only one subspecies of *Bufo vulgaris* inhabits the island of Hondo. Neither *Bufo formosus* nor *Bufo smithi* can be recognized as distinct, for there is too much variation in the size of the tympanum and web, and length of hind limb, in the series studied. The differences in size of tympana and webs seem to be partly sexual, but this is obscured by sexual variation. Notes on our specimens from Hondo follow.

15959. Kobe, Settsu Province, October, 1906. Large web; small tympanum; faint jaw line; moderate lateral pigmentation; belly heavily blotched.

15960 to 15965. Kobe, Settsu Province, September, 1906. Large webs; moderate or small tympana; jaw line present except in 15960; lateral pigmentation heavy, except in 15960, 15964, and 15965. Belly heavily spotted except in No. 15961, which has very few spots; and Nos. 15964, and 15965, which have moderate spotting. Nos. 15960, 15961, and 15962 have very spiny thighs; Nos. 15964 and 15965 have complete or partial light dorsal line; No. 15960 has first and second fingers equal; with pads, the others have the second finger longer than the first; without nuptual pads. Nos. 15961 and 15962 are females containing eggs.

16307 to 16321. Kobe, Settsu Province, October 19 to 28, 1908. The web is small in 16313, 16319, 16321; moderate in 16307, 16308 16312, 16317, 16320; large in 16309, 16310, 16311, 16312, 16314 16315, 16316, 16318. Tympanum small in 16307, 16313, 16320, 16321 moderate in 16308, 16309, 16311, 16314, 16315, 16316, 16317, 16318· large in 16310, 16312, 16319. Lateral pigment little in 16308, 16311, 16313; moderate in 16307, 16318; very pronounced in the others. Belly pigment little in 16318; moderate in 16314, 16316; very pronounced in the others. Either the first or second finger may be the longer; but in 16307, 16308, 16309, 16315 they are about equal. Nuptual finger pads are present in 16308, 16311, 16314, 16315, 16318; which have fingers of all the various lengths. The line along the lower jaw is present.

16349 to 16353. Kobe, Settsu Province, February 22, 1909. All have large webs, small or moderate tympana, heavy lateral and belly lateral and belly markings, and the line on the lower jaw. In No. 16351 the tympanum equals its distance from eye. No. 16352 is a female containing eggs.

16372. Kobe, Settsu Province, June 10, 1909. Rather large web; tympanum moderate; much lateral pigmentation; jaw line present.

16300 to 16306. Kyoto, Yamashiro Province, October 8, 22, 1908. Large webs; small tympana; jaw line present; much pigmentation of sides and belly, except in Nos. 16300 and 16304.

16290. Yura, Tango Province, September 25, 1909. Very small web; large tympanum; jaw line present; much black on sides and belly.

16291 to 16298. Miyazu, Tango Province, October, 1908. Web small, except in Nos. 16295 and 16298; tympana moderate to large; jaw line present; much lateral pigment; belly heavily spotted with black, except in Nos. 16292, 16293, and 16294, which have a few spots. No. 16298 is a female containing eggs.

25895 to 25908. Inawashiro, Iwashiro Province, 1910. Web small in Nos. 25895, 25896, 25898, 25904, and 25908; moderate in Nos. 25899, 25901, 25902, 25903, 25906, and 25907; large in Nos. 25900, and 25905. Tympanum small in Nos. 25897, 25901, and 25906; moderate in Nos. 25896, and 25900; large in Nos. 25895, 25898, 25899, 25903, 25904, 25905, 25907, and 25908; very large in No. 25902. Jaw line present in all. Not much lateral black in Nos. 25896, 25898, 25902, 25905, and 25908; not much black on belly in Nos. 25899, and 25908; a broken dorsal line in 25898.

25909 to 25921. Toyohara, Shimotsuke or Yashu Province, 1910. Large webs; tympana moderate; no jaw line; few or no belly spots. A slight tarsal ridge or row of tubercles in Nos. 25912, 25916, and 25917.

25922 and 25923. Mimaya, Rikuoku Province, 1910. Small webs; large tympana; much black on belly; reduced lateral pigmentation.

25924 and 25925. Kanida, Rikuoku Province, 1910. Small webs; large tympana; jaw line present.

25926. Shiogama, Rikuzen Province, 1910.

25927 to 25929. Tsugaru Mountains, Rikuzen Province, 1910. Small webs; large tympana; jaw line present; much lateral pigmentation; much or little ventral black.

25945 to 25947. Kawabe. Rikuoku Province, 1910. Very large webs; large tympana; jaw line present; moderate or little lateral black (largely replaced with red in two); little black on belly, except in No. 25945.

25951. Shimofuro, Rikuoku Province, 1910. Small web; large tympanum; jaw line present; no lateral black; many small black spots on belly.

### 10. **Hyla arborea japonica** Günther

A very few specimens in the large series listed below are without the dark mark between the nostril and eye.

| | |
|---|---|
| 15967 to 15969. | Kamakura Province, Oct. 13, 1906. |
| 15970. | Yokohama, Musashi Province, Oct. 1906. |
| 15971. | Kyoto, Yamashiro Province, Sept. 24, 1906. |
| 16258. | Yura, Tango Province, Sept. 20, 1908. |
| 16260. | Maiko, Tango Province, Sept. 14, 1908. |
| 16262 to 16265. | Miyazu, Tango Province, Sept. 24, 1908. |
| 16269 and 16270. | Miyazu, Tango Province, Sept. 24, 1908. |
| 16272 and 16273. | Miyazu, Tango Province, Sept. 24, 1908. |
| 16361 to 16371. | Ashiya, Settsu Province, May 9, 1909. |
| 25870 to 25872. | Mimaya, Rikuoku Province, 1910. |
| 25873 to 25877. | Inawashiro, Iwashiro Province, 1910. |
| 25878 to 25880. | Matsushima, Shinshu Province, 1910. |
| 25881 and 25882. | Asamushi, Rikuoku Province, 1910. |
| 25883. | Kanida, Rikuoku Province, 1910. |
| 25936 to 25944. | Kawabe, Rikuoku Province, 1910. |
| 35910. | Kobe, Settsu Province, 1911. |
| 35912. | Kobe, Settsu Province, 1911. |
| 35914 to 35917. | Kobe, Settsu Province, April 18–Jan. 20, 1912. |
| 35919. | Miyazu, Tango Province, July 6, 1911. |

### 11. **Rana nigromaculata nigromaculata** Hallowell

In the large series at hand the dorsal line is absent only in Nos. 15991, 15992, 16000, 16003, 16009, 16099, 16113, and 16114. This line is present only on the head and sacral region in No. 15997. In Nos. 16001 and 26727 this line is in its normal position on the head, but, on the body, it leaves the midline and crosses the left dorsolateral ridge, returning to the midline posteriorly. Our Hondo specimens are from the following localities:

| | | |
|---|---|---|
| 15991 to | 15999. | Yokohama, Musashi Province, Oct. 7, 1906. |
| 16000 to | 16011. | Kobe, Settsu Province, Sept.–Oct., 1906. |
| 16098 to | 16101. | Kobe, Settsu Province, Sept. 14, 1908. |
| 16102 to | 16113. | Yura, Tango Province, Sept. 25, 1908. |
| 16114 and | 16115. | Yura, Tango Province, Sept. 25, 1908. |
| 16116 and | 16117. | Miyazu, Tango Province, Sept. 24, 1908. |
| 16118 to | 16122. | Miyazu, Tango Province, Oct. 1908. |
| | 25816. | Shiogama, Rikuzen Province, 1910. |
| 25817 to | 25819. | Tanabu, Rikuoku Province, 1910. |
| 25820 and | 25821. | Aomori, Rikuoku Province, 1910. |
| | 25822. | Ichinoseki, Rikuoku Province, 1910. |
| | 25823. | Asamushi, Rikuoku Province, 1910. |
| 25845 and | 25846. | Inawashiro, Iwashiro Province, 1910. |
| | 25847. | Ina, Rikuoku Province, 1910. |
| | 25930. | Kawabe, Rikuoku Province, 1910. |
| | 26727. | Sekiya, Himotsuke Province, 1910. |
| 33041 and | 33042. | Kobe, Settsu Province, April 13, 1910. |

### 12. **Rana temporaria temporaria** Linnaeus

Dr. Stejneger (Proc. Biol. Soc. Wash., Vol. 37, 1924, pp. 73–78) has shown that two kinds of woodfrogs have been found on Hondo. These he calls *Rana japonica* and *Rana temporaria ornativentris*. He shows that in the frogs of the *Rana temporaria* subgroup the anterior dorso-lateral glandular ridges flare out laterally toward the tympanum, while in *Rana japonica* these ridges proceed nearly straight forward to the eyelid. He states that the large, blackish spots on the throat and breast are alone sufficient to separate *Rana temporaria ornativentris* (Werner) from typical *Rana temporaria*.

In our series of woodfrogs from Hondo I find that the dorso-lateral folds flare out toward the tympanum in the following:

| | | |
|---|---|---|
| 16146 to | 16150. | Miyazu, Tango Province, Oct. 1, 1908. |
| 25762 to | 25769. | Mimaya, Rikuoku Province, 1910. |
| 25791 to | 25798. | Tanabu, Rikuoku Province, 1910. |
| 25812 and | 25813. | Tappanzaki, Rikuoku Province, 1910. |
| | 25815. | Sendai, Rikuzen Province, 1910. |
| 25824 to | 25827. | Osorezan, Rikuoku Province, 1910. |
| 25828 and | 25829. | Omasaki, Rikuoku Province, 1910. |
| | 25931. | Kawabe, Rikuoku Province, 1910. |
| | 35911. | Kobe, Settsu Province, May 3, 1911. |

Many of these specimens show an outer, metatarsal tubercle, and most of them have shorter snouts and larger webs than are found in typical *Rana japonica*. Nearly all these frogs have the throat more or less suffused or clouded with brown or slate, but less than half of them have any definite spotting of the throat or breast. As spotting of these regions occurs in specimens of *Rana temporaria* from Sakhalin, Korea and Tsu-shima, it appears to be a question whether the name *ornativentris* for these frogs from Hondo should be retained.

I have also before me a series of thirteen frogs (Nos. 25799 to 25811) collected at Inawashiro, Iwashiro Province, in 1910. These seem to be somewhat intermediate in their characters. The dorsolateral ridge flares out in Nos. 25799, 25800, 25801, 25803, 25806, 25807, 25808, and 25809; but is nearly straight in Nos. 25802, 25804, 25805, 25810, and 25811. The throat is spotted in No. 25808; clouded in Nos. 25799, 25800, 25801, 25802, 25804, 25805, 25809, and 25810; and white in Nos. 25803, 25807 and 25811.

### 13. **Rana japonica** (Günther)

To this name may be referred the frogs with dorso-lateral folds nearly straight anteriorly, snout long, throat and breast yellowish white, and smaller webs. Such are the following:

16013 and 16014. Yokohama, Musashi Province, Oct. 7, 1906.
16015. Kobe, Settsu Province, Sept., 1906.
16127. Kobe, Settsu Province, Sept. 14, 1908.
16128 to 16145. Yura, Tango Province, Sept. 20, 1908.
16151 to 16154. Miyazu, Tango Province, Oct. 1908.
25814. Shiogama, Rikuzen Province, 1910.
35918. Miyazu, Tango Province, July 6, 1911.

### 14. **Rana rugosa** Schlegel

The very large series at hand appears to be perfectly typical. A quite small number of the specimens show a middorsal light stripe. The following list gives the localities of collection.

15972 to 15990. Kobe, Settsu Province, Sept. 1906.
16210 to 16217. Miyazu, Tango Province, Sept. 24, 1908.
16218 to 16226. Miyazu, Tango Province, Oct., 1908.
16227 to 16239. Yura, Tango Province, Sept. 20, 1908.
16240 and 16241. Yura, Tango Province, Oct. 25, 1908.
16242 to 16252. Kobe, Settsu Province, Oct. 1908.
16359 and 16360. Ashiya, Settsu Province, May 9, 1909.
25830 to 25833. Shiogama, Rikuzen Province, 1910.
25834. Aomori, Rikuoku Province, 1910.
25835 and 25836. Inawashiro, Iwashiro Province, 1910.
25837 and 25838. Asamushi, Rikuoku Province, 1910.
25839. Mimaya, Rikuoku Province, 1910.
25840. Nakayama, Aki Province, 1910.
25841 to 25843. Ina, Rikuoku Province, 1910.
25844. Ichinoseki, Rikuchu Province, 1910.
25848 and 25849. Ichinoseki, Rikuchu Province, 1910.
25932 to 25935. Kawabe, Rikuoku Province, 1910.
26723 to 26726. Sekiya, Himotsuke Province, 1910.
33043 and 35907. Kobe, Settsu Province, 1911.
35913 and 35930. Kobe, Settsu Province, 1912.

### 15. **Rana limnocharis** Wiegmann

This frog is represented by twenty-four specimens from Hondo.

16163. Kobe, Settsu Province, Sept. 14, 1908.
16164 to 16167. Yura, Tango Province, Sept. 20, 1908.
16168 to 16179. Miyazu, Tango Province, Sept. 24, 1908.
16180 to 16182. Miyazu, Tango Province, Oct. 1, 1908.
16348. Miyazu, Tango Province, Oct. 1, 1908.
35908 and 35909. Kobe, Settsu Province, April 26, 1911.

### 16. **Rhacophorus schlegelii schlegelii** (Günther)

Twenty specimens from Hondo are at hand, as follows:

16255 to 16257. Yura, Tango Province, Sept. 20, 1908.
16259. Yura, Tango Province, Sept. 20, 1908.
16261. Miyazu, Tango Province, Sept. 24, 1908.
16266 to 16268. Miyazu, Tango Province, Sept. 24, 1908.
16271. Miyazu, Tango Province, Sept. 24, 1908.
16274 to 16276. Miyazu, Tango Province, Sept. 24, 1908.
16277 to 16279. Miyazu, Tango Province, Oct. 1–5, 1908.
25892 and 25893. Tappanzaki, Rikuoku Province, 1910.
25894. Aomori, Rikuoku Province, 1910.
26734. Yamato, Yamato Province, 1910.
33051. Miyazu, Tango Province, July 6, 1911.

### 17. **Polypedates buergeri** (Schlegel)

The ten specimens listed below require no special comment.

15966. Mount Fuji, Suguru Province, May, 1898.
24337. Kobe, Settsu Province.
25884 to 25886. Lake Inawashiro, Iwashiro Province, 1910.
25887 to 25891. Yamashiro, Kaga Province, 1910.

### 18. **Gekko japonicus** (Duméril & Bibron)

This species is represented by eleven specimens from Hondo.

16041. Osaka, Settsu Province, Oct. 26, 1908.
33020 to 33026. Kobe, Settsu Province, July 10, 1911.
35904 to 35906. Kobe, Settsu Province, August, 1911.

### 19. **Takydromus tachydromoides** (Schlegel)

More than fifty specimens from Hondo are at hand. There appears to be no character to distinguish them from the grass lizards of the other islands of Japan proper.

15830 to 15833. Yokohama, Musashi Province, Oct. 1906.
15834 to 15851. Kobe, Settsu Province, Sept. 23–25, 1906.
16042. Maiko, Harima Province, Sept. 14, 1908.
16043 to 16045. Miyazu, Tango Province, Sept. 1908.
16046 to 16056. Miyazu, Tango Province, Oct. 1, 1908.
16062. Kobe, Settsu Province, Oct. 28, 1908.
16354 to 16357. Kobe, Settsu Province, June 10, 1909.
25952. Osorezan, Rikuoku Province, 1910.
25953. Shiogama, Rikuzen Province, 1910.
25954. Inawashiro, Iwashiro Province, 1910.
33035 to 33040. Kobe, Settsu Province, April 13, 1911.
35900 to 35903. Kobe, Settsu Province, 1911.

### 20. **Eumeces latiscutatus latiscutatus** (Hallowell)

This lizard is represented in our collections by the following specimens from Hondo:

15852 and 15853. Kobe, Settsu Province, Sept. 24, 1906.
16358. Kobe, Settsu Province, Sept. 24, 1906.
33027 to 33031. Kobe, Settsu Province, April 13, 1911.
33032 to 33034. Kobe, Settsu Province, May 3, 1911.
33045 to 33050. Miyazu, Tango Province, July 6, 1911.
35899. Kobe, Settsu Province, 1911.

## 21. **Natrix vibakari vibakari** (Boie)

Nine specimens of this snake are represented as follows:

15854 and 15855. Hakone, Suruga Province, Oct. 28, 1906.
15856 and 15860. Yokohama, Musashi Province, Oct. 1–7, 1906.
15861. Yokohama, Musashi Province, 1906.
16085. Miyazu, Tango Province, Oct. 5, 1908.

The scale counts of these specimens are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|
| 15854 | ♂ | 19 | 146 | 77c | 7–7 | 8–8 | 1–1 | 3–2 | 1–1 | 1+1–1+1 |
| 15855 | ♀ | 19 | 143 | 76c | 7–7 | 8–8 | 1–1 | 2–2 | 1–1 | 1+1–1+1 |
| 15856 | ♂ | 19 | 148 | 69c | 7–7 | 8–8 | 1–1 | 3–3 | 1–1 | 1+1–1+1 |
| 15857 | ♂ | 19 | 145 | 73c | 7–7 | 8–8 | 1–1 | 3–3 | 1–1 | 1+1–1+1 |
| 15858 | ♀ | 19 | 145 | 70c | 7–7 | 9–8 | 1–1 | 3–3 | 1–1 | 1+1–1+1 |
| 15859 | ♂ | 19 | 148 | 58c | 7–7 | 8–8 | 1–1 | 3–3 | 1–1 | 1+1–1+1 |
| 15860 | ♂ | 19 | 149 | 71c | 7–7 | 8–8 | 1–1 | 3–3 | 1–1 | 1+1–1+1 |
| 15861 | ♀ | 19 | 150 | 70c | 7–7 | 8–8 | 1–1 | 3–3 | 1–1 | 1+1–1+1 |
| 16085 | ♂ | 19 | 146 | 74c | 8–7 | 8–8 | 1–1 | 3–3 | 1–1 | 1+1–1+1 |

## 22. **Natrix tigrina tigrina** (Boie)

This snake is represented by more than ninety specimens from Hondo. The combined gastrostege and urostege counts vary from 113 to 142, but usually are more than 126, as stated by Stejneger. The urosteges range from 59 to 80. The localities and the scale counts for these specimens are given below.

15862 to 15925. Yokohama, Musashi Province, Oct. 1, 1906.
15926 to 15929. Kobe, Settsu Province, Sept. 25, 1906.
15932. Yumoto, Suruga Province, Oct. 20, 1906.
15933. Hakone, Suruga Province, Oct. 20, 1906.
16063 to 16069. Yura, Tango Province, Sept. 25, 1908.
16070 to 16077. Miyazu, Tango Province, Sept. 23–Oct. 11, 1908.
25955. Osorezan, Rikuoku Province, 1910.
26677. Inawashiro, Iwashiro Province, 1910.
26678. Ichinoseki, Rikuoku Province, 1910.
26680. Mimaya, Rikuoku Province, 1910.
26682. Tappanzaki, Rikuoku Province, 1910.
26684. Osorezan, Rikuoku Province, 1910.
33018. Kobe, Settsu Province, May 3, 1911.

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|
| 15862 | ♂ | 19 | 156 | 74c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+1 |
| 15863 | ♂ | 19 | 157 | 69c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15864 | ♂ | 19 | 158 | 76c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15865 | ♂ | 19 | 157 | 75c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15866 | ♂ | 19 | 154 | 70c | 2 | 8–7 | 10–10 | 2–2 | 3–3 | 1+2−1+2 |
| 15767 | ♂ | 19 | 159 | 50+ | 2 | 7–7 | 9–9 | 2–2 | 3–4 | 1+2−1+2 |
| 15868 | ♀ | 19 | 162 | 68c | 2 | 6–7 | 9–8 | 2–2 | 3–3 | 1+2−1+2 |
| 15869 | ♀ | 19 | 163 | 67c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15870 | ♂ | 19 | 163 | 71c | 2 | 7–7 | 8–9 | 2–2 | 3–3 | 1+2−1+1 |
| 15871 | ♀ | 19 | 166 | 72c | 2 | 7–7 | 8–8 | 2–2 | 3–4 | 1+2−1+2 |
| 15872 | ♀ | 19 | 165 | 58+ | 2 | 7–7 | 8–8 | 2–2 | 3–3 | 1+2−1+2 |
| 15873 | ♀ | 19 | 161 | 65c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15874 | ♀ | 19 | 169 | 72c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15875 | ♂ | 19 | 160 | 72c | 2 | 6–7 | 8–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15876 | ♂ | 19 | 155 | 28+ | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15877 | ♂ | 19 | 159 | 76c | 2 | 6–7 | 8–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15878 | ♂ | 19 | 156 | 73c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15879 | ♀ | 19 | 161 | 64c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15880 | ♀ | 19 | 162 | 65c | 2 | 7–7 | 9–9 | 2–2 | 4–3 | 1+2−1+2 |
| 15881 | ♂ | 19 | 162 | 80c | 2 | 7–7 | 9–9 | 2–2 | 2–2 | 1+2−1+2 |
| 15882 | ♀ | 19 | 162 | 69c | 2 | 7–7 | 8–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15883 | ♂ | 19 | 159 | 78c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15884 | ♂ | 19 | 159 | 78c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15885 | ♂ | 19 | 162 | 73c | 2 | 6–7 | 8–9 | 2–2 | 3–4 | 1+2−1+2 |
| 15886 | ♂ | 19 | 162 | 73c | 2 | 6–6 | 9–8 | 2–2 | 3–3 | 1+1−1+2 |
| 15887 | ♂ | 19 | 161 | 73c | 2 | 7–7 | 8–9 | 2–2 | 4–3 | 1+2−1+2 |
| 15888 | ♀ | 19 | 162 | 66c | 2 | 7–7 | 10–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15889 | ♂ | 19 | 155 | 70c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15890 | ♀ | 19 | 162 | 71c | 2 | 7–7 | 9–9 | 2–2 | 4–3 | 1+2−1+2 |
| 15891 | ♂ | 19 | 154 | 73c | 2 | 7–7 | 9–9 | 2–2 | 3–4 | 1+2−1+2 |
| 15892 | ♂ | 19 | 158 | 66c | 2 | 7–7 | 9–10 | 2–2 | 3–3 | 1+2−1+2 |
| 15893 | ♀ | 19 | 165 | 68c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15894 | ♂ | 19 | 160 | 63c | 2 | 7–7 | 8–8 | 2–2 | 3–3 | 1+2−1+2 |
| 15895 | x | 19 | 164 | 73c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15896 | ♂ | 19 | 161 | 54+ | 2 | 6–6 | 8–7 | 2–2 | 3–3 | 1+2−1+2 |
| 15897 | ♂ | 19 | 160 | 72c | 2 | 6–6 | 8–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15898 | ♀ | 19 | 162 | 62c | 2 | 7–7 | 8–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15899 | ♂ | 19 | 157 | 78c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15900 | ♀ | 19 | 167 | 71c | 2 | 7–7 | 9–8 | 2–2 | 3–3 | 1+2−1+2 |
| 15901 | ♂ | 19 | 159 | 75c | 2 | 7–7 | 8–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15902 | ♀ | 19 | 159 | 30+ | 2 | 6–6 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15903 | ♂ | 19 | 160 | 58+ | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15904 | ♂ | 19 | 161 | 73c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15905 | ♀ | 19 | 161 | 59+ | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15906 | ♂ | 19 | 158 | 76c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15907 | ♀ | 19 | 162 | 69c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15908 | ♀ | 19 | 161 | 70c | 2 | 7–7 | 9–9 | 2–2 | 3–2 | 1+2−1+2 |
| 15909 | ♀ | 19 | 162 | 70c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15910 | ♂ | 19 | 159 | 75c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15911 | ♀ | 19 | 163 | 71c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15912 | ♂ | 19 | 162 | 74c | 2 | 6–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15913 | ♀ | 19 | 164 | 70c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15914 | ♂ | 19 | 157 | 75c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15915 | ♂ | 19 | 162 | 78c | 2 | 7–7 | 9–9 | 2–2 | 4–4 | 1+2−1+2 |
| 15916 | ♀ | 19 | 163 | 75c | 2 | 7–7 | 9–9 | 2–2 | 3–4 | 1+2−1+2 |
| 15917 | ♂ | 19 | 160 | 75c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15918 | ♂ | 19 | 157 | 59+ | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2−1+2 |
| 15919 | ♀ | 19 | 161 | 66c | 2 | 7–7 | 8–8 | 2–2 | 3–3 | 1+2−1+1 |
| 15920 | ♀ | 19 | 162 | 66c | 2 | 7–7 | 10–9 | 2–2 | 3–4 | 1+2−1+2 |

| No. | Sex | Scale Rows | Gastro-steges | Uro-steges | Anal | Supra-labials | Infra-labials | Pre-oculars | Post-oculars | Temporals |
|---|---|---|---|---|---|---|---|---|---|---|
| 15921 | ♀ | 19 | 162 | 54+ | 2 | 7–7 | 9–8 | 2–2 | 3–3 | 1+2–1+2 |
| 15922 | ♀ | 19 | 162 | 71c | 2 | 7–7 | 9–9 | 2–2 | 4–4 | 1+2–1+2 |
| 15923 | ♀ | 19 | 167 | 64c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2–1+2 |
| 15924 | x | 19 | | | | | | | | |
| 15925 | ♂ | 19 | 159 | 73c | 2 | 7–6 | 8–8 | 2–2 | 3–3 | 1+2–1+2 |
| 15926 | ♀ | 19 | 157 | 73c | 2 | 7–6 | 9–9 | 1–1 | 3–3 | 1+2–1+2 |
| 15927 | ♀ | 19 | 161 | 70c | 2 | 7–7 | 10–10 | 2–2 | 3–4 | 1+2–1+2 |
| 15928 | ♀ | 19 | 160 | 66c | 2 | 7–7 | 9–9 | 2–2 | 4–3 | 1+2–1+2 |
| 15929 | ♂ | 19 | 156 | 79c | 2 | 7–7 | 9–8 | 2–2 | 3–3 | 1+2–1+2 |
| 15932 | ♀ | 19 | 165 | 69c | 2 | 7–7 | 10–9 | 2–2 | 3–3 | 1+2–1+2 |
| 15933 | ♀ | 19 | 163 | 68c | 2 | 7–7 | 10–10 | 2–2 | 4–4 | 1+2–1+2 |
| 16063 | ♂ | 19 | 163 | 74c | 2 | 7–7 | 8–9 | 2–2 | 3–3 | 1+2–1+2 |
| 16064 | ♂ | 19 | 155 | 77c | 2 | 7–7 | 8–8 | 2–2 | 3–3 | 1+2–1+2 |
| 16065 | ♂ | 19 | 156 | 79c | 2 | 7–7 | 10–9 | 2–2 | 3–3 | 1+2–1+2 |
| 16066 | ♂ | 19 | 158 | 76c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2–1+2 |
| 16067 | ♀ | 19 | 157 | 70c | 2 | 7–7 | 9–10 | 2–2 | 3–3 | 1+2–1+2 |
| 16068 | ♀ | 19 | 164 | 72c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2–1+2 |
| 16069 | ♀ | 19 | 158 | 73c | 2 | 7–7 | 9–9 | 2–2 | 4–4 | 1+2–1+2 |
| 16070 | ♀ | 19 | 155 | 72c | 2 | 7–7 | 10–10 | 2–2 | 3–3 | 1+2–1+2 |
| 16071 | ♂ | 19 | 158 | 74c | 2 | 7–7 | 10–9 | 2–2 | 3–3 | 1+2–1+2 |
| 16072 | ♀ | 19 | 158 | 70c | 2 | 6–7 | 10–10 | 2–2 | 3–3 | 1+2–1+3 |
| 16073 | ♂ | 19 | 155 | 79c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2–1+2 |
| 16074 | ♀ | 19 | 160 | 75c | 2 | 7–7 | 10–10 | 2–2 | 3–3 | 1+2–1+2 |
| 16075 | ♀ | 19 | 155 | 80c | 2 | 7–7 | 10–10 | 2–2 | 3–3 | 2+2–1+2 |
| 16076 | ♀ | 19 | 158 | 71c | 2 | 7–7 | 10–10 | 2–2 | 3–3 | 1+2–1+2 |
| 16077 | ♀ | 19 | 162 | 61c | 2 | 7–7 | 10–9 | 2–2 | 3–3 | 1+2–1+2 |
| 25955 | ♀ | 19 | 152 | 61c | 2 | 8–7 | 10–10 | 2–2 | 3–3 | 1+2–1+2 |
| 26677 | ♂ | 19 | 154 | 63c | 2 | 7–7 | 8–8 | 2–2 | 3–3 | 1+2–1+2 |
| 26678 | ♂ | 19 | 154 | 69c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2–1+2 |
| 26680 | ♂ | 19 | 154 | 61c | 2 | 8–7 | 9–9 | 2–2 | 3–3 | 1+2–1+2 |
| 26682 | ♂ | 19 | 153 | 69c | 2 | 8–8 | 10–10 | 2–2 | 3–3 | 1+2–1+2 |
| 26684 | ♂ | 19 | 154 | 59c | 2 | 6–6 | 9–9 | 2–2 | 3–3 | 1+2–1+2 |
| 33018 | ♂ | 19 | 161 | 77c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2–1+2 |

The loreals are 1–1 in all except Nos. 15887 and 15929, which have none.

### 23. **Elaphe climacophora** (Boie)

No. 15947 is a female, collected at Tokyo, Musashi Province, in August, 1906. It has scales in 25 rows, gastrosteges 225, urosteges 99c, anal divided, supralabials 8–8, infralabials 11–11, preoculars 1–1, postoculars 2–2, loreal 1–1, and temporals 2+3–2+3.

### 24. **Elaphe quadrivirgata** (Boie)

Sixteen Hondo specimens of this snake are at hand.

15950 to 15953. Yokohama, Musashi Province, Oct. 1, 1906.
15954 and 15955. Kobe, Settsu Province, Sept. 25, 1906.
16082 to 16084. Miyazu, Tango Province, Sept.–Oct. 5, 1908.
16086 and 16087. Yura, Tango Province, Sept. 21 and 25, 1908.
16089 to 16091. Yura, Tango Province, Sept. 25 and 26, 1908.
26679. Mimaya, Rikuoku Province, 1910.
33019. Kobe, Settsu Province, May 3, 1911.

The scale counts are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|
| 15950 | ♂ | 19 | 208 | 48+ | 2 | 8–8 | 9–9 | 2–2 | 2–2 | 2+2–2+3 |
| 15951 | ♂ | 19 | 202 | 88c | 2 | 8–8 | 9–10 | 2–2 | 2–2 | 2+2–2+3 |
| 15952 | ♂ | 19 | 204 | 88c | 2 | 9–8 | 10–10 | 1–2 | 2–2 | 2+3–2+3 |
| 15953 | ♂ | 19 | 202 | 90c | 2 | 7–7 | 10–9 | 1–1 | 2–2 | 2+2–2+3 |
| 15954 | ♀ | 19 | 203 | 86c | 2 | 8–8 | 10–10 | 2–2 | 2–2 | 2+2–2+2 |
| 15955 | ♂ | 19 | 205 | 90c | 2 | 8–8 | 10–10 | 1–2 | 2–2 | 2–2 |
| 16082 | ♀ | 19 | 198 | 77c | 2 | 8–8 | 9–10 | 1–1 | 2–2 | 2+2–2+2 |
| 16083 | ♂ | 19 | 204 | 92c | 2 | 8–8 | 9–10 | 1–1 | 2–2 | 2+3–2+2 |
| 16084 | ♀ | 19 | 198 | 81c | 2 | 8–8 | 10–10 | 1–1 | 2–2 | 2+2–2+2 |
| 16086 | ♀ | 19 | 206 | 81c | 2 | 8–8 | 10–10 | 2–2 | 2–2 | 2+2–2+2 |
| 16087 | ♀ | 19 | 203 | 77c | 2 | 8–8 | 10–10 | 2–2 | 2–2 | 2+2–2+2 |
| 16089 | ♂ | 19 | 203 | 87c | 2 | 8–8 | 10–10 | 2–2 | 2–2 | 1+2–2+2 |
| 16090 | ♂ | 19 | 203 | 89c | 2 | 8–8 | 10–10 | 2–1 | 2–2 | 2+2–2+2 |
| 16091 | ♀ | 19 | 198 | 87c | 2 | 8–8 | 10–10 | 2–2 | 2–2 | 2+3–2+3 |
| 26679 | ♂ | 19 | 201 | 68+ | 1 | 8–8 | 10–9 | 2–2 | 2–2 | 2+2–2+2 |
| 33019 | ♂ | 19 | 203 | 88c | 2 | 8–8 | 10–10 | 2–2 | 2–2 | 2+2–2+2 |

The gastrostege counts of Hondo specimens range from 198 to 213, the averages being for nineteen males 205; for eighteen females 203.2; and for fifty specimens 204.2. The urosteges range from 70 to 92, and average for fifteen males 87.6; for eighteen females 82.1; and for forty-five specimens 84.9.

## 25. **Elaphe conspicillata** (Boie)

The collection includes only three snakes of this species from Hondo.

15945. Yumoto, Suruga Province, Oct. 20, 1906.
15946. Yokohama, Musashi Province, Oct. 20, 1906.
26676. Inawashiro, Iwashiro Province, 1910.

The scale counts are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|
| 15945 | ♀ | 21 | 213 | 69c | 2 | 7–7 | 9–9 | 1–1 | 2–2 | 1+2–1+2 |
| 15946 | ♂ | 21 | 202 | 68c | 2 | 7–7 | 9–9 | 1–1 | 2–2 | 1+2–1+2 |
| 26676 | ♂ | 21 | 214 | 54+ | 2 | 7–7 | 9–9 | 1–1 | 2–2 | 1+2–1+2 |

## 26. **Dinodon orientale** (Hilgendorf)

We have one specimen (No. 15937) from Kobe, Settsu, Province, Sept. 24, 1906, and seven (Nos. 15938 to 15944) from Yokohama, Musashi Province, 1906. The scale counts are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|
| 15937 | ♂ | 17 | 195 | 73c | 2 | 8–8 | 9–9 | 1–1 | 2–2 | 2+2−2+2 |
| 15938 | ♀ | 17 | 186 | 74c | 2 | 8–8 | 10–10 | 1–1 | 2–2 | 2+3−2+3 |
| 15939 | ♀ | 17 | 201 | 73c | 2 | 8–8 | 10–9 | 1–1 | 2–2 | 2+2−2+3 |
| 15940 | ♂ | 17 | 197 | 72c | 2 | 8–8 | 9–10 | 1–1 | 2–2 | 2+2−2+3 |
| 15941 | ♀ | 17 | 205 | 72c | 2 | 8–8 | 9–10 | 1–1 | 2–2 | 2+3−2+3 |
| 15942 | x | 17 | 200 | 72c | 2 | 8–8 | 10–10 | 1–1 | 2–2 | 2+2−2+3 |
| 15943 | ♀ | 17 | 204 | 70c | 2 | 8–8 | 10–10 | 1–1 | 2–2 | 2+3−2+3 |
| 15944 | ♀ | 17 | 197 | 73c | 2 | 8–8 | 10–10 | 1–1 | 2–2 | 2+3−2+3 |

## 27. **Pelamydrus platurus** (Linné)

A single sea-snake of this species (No. 15000) was taken in Suruga Bay, Feb. 1, 1906. It is a male, and has scales in 47 rows on the neck and 51 on the body, gastrosteges 327, urosteges 42c, anal divided, supralabials 9–8, infralabials 11–12, preoculars 2–1, postoculars 2–2, and temporals 2+3−2+3.

## 28. **Agkistrodon blomhoffii blomhoffii** (Boie)

Five typical specimens from Hondo are represented in the collection.

15956 and 15957. Yokohama, Musashi Province, 1906.
15958. Kobe, Settsu Province, Sept. 24, 1906.
16906. Miyazu, Tango Province, Oct. 5, 1908.
25957. Tappanzaki, Rikuoku Province, 1910.

The scale counts are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* |
|---|---|---|---|---|---|---|---|---|---|
| 15956 | juv. | 21 | 136 | 45c | 1 | 7–7 | 10–10 | 2–2 | 2–2 |
| 15957 | ♀ | 21 | 144 | 46c | 1 | 7–7 | 11–10 | 2–2 | 2–2 |
| 15958 | ♂ | 21 | 140 | 54c | 1 | 7–7 | 10–10 | 2–2 | 2–2 |
| 16096 | ♀ | 21 | 143 | 48c | 1 | 7–7 | 10–10 | 2–2 | 2–2 |
| 25957 | juv. | 21 | 138 | 53c | 1 | 7–7 | 10–10 | 2–2 | 2–2 |

### 29. **Clemmys japonica** (Temminck and Schlegel)

Two young turtles of this species (Nos. 15825 and 15826) were collected at Yokohama, Musashi Province, Oct. 1906; No. 16038, an adult with black lower surfaces, was taken at Miyazu, Tango Province, Sept. 25, 1908.

### 30. **Geoclemys reevesii** (Gray)

No. 15827 was collected at Yokohama, Musashi Province, Oct. 31, 1906. Two large, black specimens (Nos. 15828 and 15829) were collected at Kobe, Settsu Province, Sept. 25, 1906. They are without markings, even on the sides of the neck.

### 31. **Chelonia japonica** (Thunberg)

A young, green turtle (No. 15823) is labeled merely "Nippon."

### 32. **Amyda japonica** (Temminck and Schlegel)

No. 15824 is a young, soft-shelled turtle taken at Tokyo, Musashi Province.

## SADO ISLAND

### 1. **Rana temporaria temporaria** Linné

Two frogs were collected at Aikawa, Sado Island, Oct. 6, 1909. They have short snouts, large webs, unspotted throats, and dorsolateral ridges which flare out toward the tympanum. The outer metatarsal tubercle is present in both. The vomerine teeth are behind the choanæ in No. 26756; between and behind in No. 26755. It is interesting to know that *Rana temporaria* is the frog of this small island which lies near the west coast of Hondo.

## AWAJI ISLAND

### 1. **Triturus pyrrhogaster** (Boie)

Six specimens (Nos. 16341 to 16346) were collected at Sumoto, Oct. 11, 1908.

### 2. **Bufo vulgaris japonicus** Schlegel

Two specimens of this toad were taken at Fukura.

16299. Oct. 16, 1908. Large webs; large tympanum; faint dark line on lower jaw; reduced black on sides and belly.

16423. June 17, 1909. Large web; large tympanum; faint jaw line; few spots on belly.

### 3. **Hyla aborea japonica** Günther

Thirty-four specimens are represented, as follows:

| | | |
|---|---|---|
| 16280 and | 16281. | Fukura, Oct. 16, 1908. |
| 16282 to | 16289. | Sumoto, Oct. 11, 1908. |
| | 16347. | Sumoto, Oct. 11, 1908. |
| 16395 to | 16402. | Yura, June 21, 1909. |
| 16405 to | 16407. | Habu, June 20, 1909. |
| 16411 to | 16415. | Fukura, June 17, 1909. |
| 16416 to | 16422. | Fukura, June 18, 1909. |

### 4. **Rana nigromaculata nigromaculata** Hallowell

Four frogs of this species (Nos. 16123 to 16126) were secured at Sumoto, Oct. 11, 1908.

### 5. **Rana japonica** (Günther)

Seven typical specimens (Nos. 16155 to 16161) were collected at Fukura, Oct. 15, 1908. They all have long snouts and small webs. The vomerine teeth are between the choanæ in Nos. 16158, 16159, and 16161; between and behind the choanæ in Nos. 16155, 16156, and 16157; and mostly behind in No. 16160. The dorsolateral glandular ridge is nearly straight anteriorly in all seven.

### 6. **Rana rugosa** Schlegel

Twenty specimens (Nos. 16190 to 16209) were collected at Sumoto, Oct. 11, 1908.

### 7. **Rana limnocharis** Wiegmann

We have seven frogs of this species from Awaji Island. Two of these (Nos. 16183 and 16184) were taken at Fukura in Oct., 1908. The others (Nos. 16185 to 16189) were collected at Sumoto, Oct. 11, 1906.

### 8. **Takydromus tachydromoides** (Schlegel)

Eight grass lizards of this species are represented as follows:

| | | |
|---|---|---|
| 16057 to | 16060. | Sumoto, Oct. 2, 1908. |
| | 16061. | Fukura, Oct. 14, 1908. |
| | 16404. | Habu, June 20, 1909. |
| 16409 and | 16410. | Fukura, June 17, 1909. |

### 9. **Natrix tigrina tigrina** (Boie)

Four specimens from Sumoto have the following scale counts:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|
| 16078 | ♂ | 19 | 151 | 83c | 2 | 7–7 | 9–9 | 2–2 | 3–3 | 1+2–1+2 |
| 16079 | ♀ | 19 | 161 | 67c | 2 | 7–7 | 8–9 | 2–2 | 3–3 | 1+2–1+2 |
| 16080 | ♀ | 19 | 163 | 71c | 2 | 7–7 | 10–9 | 2–2 | 3–3 | 1+2–1+2 |
| 16081 | ♀ | 19 | 163 | 76c | 2 | 7–7 | 9–9 | 2–2 | 4–3 | 1+2–1+2 |

### 10. **Elaphe quadrivirgata** (Boie)

Four of these snakes (Nos. 16092 to 16095) collected at Sumoto, Oct. 11, 1908, and one (No. 16408) secured at Fukura, June 18, 1909, give the following scale counts:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|
| 16092 | ♀ | 19 | 197 | 85c | 1 | 8–8 | 11–11 | 2–2 | 2–2 | 2+2–2+2 |
| 16093 | ♂ | 19 | 205 | 90+ | 2 | 8–8 | 10–9 | 2–2 | 2–2 | 2+3–2+2 |
| 16094 | ♂ | 19 | 200 | 91c | 1 | 8–9 | 10–10 | 2–2 | 2–2 | 2+3–2+2 |
| 16095 | ♂ | 19 | 202 | 89c | 1 | 8–8 | 10–10 | 2–2 | 2–2 | 2+2–2+3 |
| 16408 | ♂ | 19 | 206 | 92c | 1 | 8–8 | 10–10 | 2–2 | 2–2 | 2+2–2+2 |

### 11. **Agkistrodon blomhoffii blomhoffii** (Boie)

No. 16097 is a male taken at Fukura, Oct. 14, 1908. It has scales in 21 rows, gastrosteges 142, urosteges, 49, anal single, supralabials 7–7, infralabials 10–11, preoculars 2–2, postoculars 2–2, and temporals 1+3–1+3.

## THE SEVEN ISLANDS OF IDZU

### 1. **Eumeces latiscutatus okadae** Stejneger

Our only specimen of this lizard (No. 27229) is one of the original specimens described by Dr. Stejneger. It formerly was No. 36531 of the U. S. National Museum collection, and was collected by Okada on Nii shima, Idzu. It has twenty-eight scales around the body, fifty-four between the parietals and the backs of the thighs, eighteen under the fourth toe, seven supralabials, and one and three nuchals, as recorded in these Proceedings, Ser. 4, Vol. III, 1912, p. 214.

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No. 12

# MARINE MOLLUSCA OF SAN MARTIN ISLAND, MEXICO*

BY

A. M. STRONG

During the 1925 expedition of the California Academy of Sciences to the islands off the coast of Lower California, G. D. Hanna and E. K. Jordan secured a quantity of drift which had been cast up by a storm in a small cove on the south side of San Martin Island. In this drift there was a large number of the so called microscopic species. In all, 107 species have been identified from this material. In connection with the work of identification, comparison was made with a list of species collected on the same island by Dr. Fred Baker of San Diego, and published by him in the Nautilus, vol. 16, 1903, p. 40. The comparison indicated a number of changes which should be made in Dr. Baker's list, largely caused by the use of Carpenter's and C. B. Adams' names for shells, which are now considered to be confined to the Gulf of California and Panama.

Dr. Baker very kindly made his collection available for reidentification. In addition to the named species there was some unidentified material, chiefly microscopic forms. This makes it possible to extend his list and bring the nomenclature down to date. The fauna of San Martin Island is of particular interest, in that it marks the southern known limit of the range of a considerable number of California species.

The following list contains the names of 199 species of Mollusca now known to occur at San Martin Island. These are represented in one or both of the collections of the Academy and of Dr. Baker.

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* Printed from the John W. Hendrie Publication Endowment.

The nomenclature used is mostly that suggested by Drs. Grant and Gale in their recent monograph of the Pliocene and Pleistocene Mollusca of California.[1] Some further modifications will have to be made after more detailed study is given to the smaller groups, and to the species not included in their work.

## PELECYPODA

*Arca solida* Broderip & Sowerby
**Bernardina bakeri* Dall[2]
*Chama pellucida* Broderip
*Chama squamuligera* Pilsbry & Lowe (*Chama spinosa* Sby.)
**Chironia suborbicularis* Montagu (*Kellia suborbicularis* Montagu)
**Cumingia lamellosa* Sowerby
*Glans carpenteri* Lamy (*Cardita subquadrata* Carpenter, and *Glans minuscula* Grant and Gale)
*Hinnites multirugosus* Gale (*Hinnites giganteus* Gray)
**Kellia rubra* Montagu (*Lasaea rubra* Montagu)
*Kellia rubra subviridis* Carpenter
**Lima dehiscens* Conrad
**Lucina* (*Myrtea*) *acutilineata* Conrad (*Phacoides annulatus* Reeve)
*Lucina* (*Myrtea*) *approximata* Dall
**Lucina* (*Myrtea*) *californica* Conrad
*Lucina* (*Myrtea*) *nuttallii* Conrad
*Macoma secta* Conrad
**Milneria kelseyi* Dall
*Milneria minima* Dall
*Monia foliata* Broderip
*Mytilus californianus* Conrad
*Pecten* (*Leptopecten*) *latiauratus* Conrad
*Petricola carditoides* Conrad
**Philobrya setosa* Carpenter
*Psephidia* (?) *salmonea* Carpenter
*Pseudochama exogyra* Conrad
**Saxicava arctica* Linnaeus
*Saxidomus nuttalli* Conrad
*Semele decisa* Conrad
*Septifer bifurcatus* Reeve
**Solemya panamensis* Dall
*Taras orbellus* Gould (*Diplodonta orbella* Gould)
*Tellina bodegensis* Hinds
*Tivela stultorum* Mawe
**Transennella tantilla* Gould
*Venerupis* (*Protothaca*) *staminea* Conrad (*Paphia staminea* Conrad)
*Venus* (*Antigona*) *fordii* Yates
**Volsella coralliophagus* Gmelin (*Modiolus opifex* Say)

## GASTROPODA

*Acanthina lugubris* Sowerby
*Acmaea digitalis* Eschscholtz
*Acmaea insessa* Hinds
**Acmaea limatula* Carpenter
**Acmaea paleacea* Gould
**Acmaea rosacea* Carpenter
**Acmaea scabra* Gould
**Aesopus sanctus* Dall
*Alaba jeannettae* Bartsch
*Alabina tenuisculpta* Carpenter
**Aletes squamigerus* Carpenter
*Alvania acutilirata* Carpenter
**Alvania aequisculpta* Keep
**Alvania cosmia* Bartsch
**Alvania oldroydae* Bartsch
**Alvania purpurea* Dall
**Amphissa versicolor* Dall
**Amphithalamus inclusus* Carpenter
**Anachis* (*Chauvetia*) *penicillata* Carpenter
*Astraea* (*Pomaulax*) *undosa* Wood
**Barleeia haliotiphila* Carpenter
*Barleeia subtenuis* Carpenter
**Bittium catalinense* Bartsch
**Bittium interfossum* Carpenter
**Bittium purpureum* Carpenter
**Bittium quadrifilatum* Carpenter
*Bursa californica* Hinds
**Caecum californicum* Dall
**Caecum dalli* Bartsch
**Caecum licalum* Bartsch
*Calliostoma splendens* Carpenter
*Cerithidea californica* Haldeman
**Cerithiopsis bakeri* Bartsch
**Cerithiopsis cosmia* Bartsch
**Cerithiopsis halia* Bartsch

[1] U. S. Grant IV and H. R. Gale. Mem. San Diego Soc. Nat. Hist., vol. 1, 1931.

[2] Species represented in the collection of the California Academy of Sciences, are indicated by an asterisk.

**Cerithiopsis oxys* Bartsch
*Clathurella affinis* Dall (*Philbertia affinis* Dall)
**Conus californicus* Hinds
**Crepidula aculeata* Gmelin
**Crepidula lingulata* Gould
**Crepidula nummaria* Gould
*Crepidula onyx* Sowerby
*Cypraea spadicea* Gray
**Diala acuta* Carpenter
**Diodora inaequalis* Sowerby
*Engina trachysoma* Dall (*Engina carbonaria* Reeve)
**Epitonium* (*Dentiscala*) *crenimarginatum* Dall
**Epitonium* (*Nitidiscala*) *tinctum* Carpenter
**Fartulum hemphilli* Bartsch
**Fartulum occidentale* Bartsch
**Fartulum orcutti* Dall
**Fissurella obscura* Sowerby
**Fissurella volcano* Reeve
*Fusinus luteopictus* Dall
**Gadina reticulata* Sowerby
*Haliotis cracherodii* Leach
*Haliotis fulgens* Philippi
**Hipponix antiquatus* Linnaeus
**Hipponix tumens* Carpenter
**Homalopoma bacula* Carpenter (*Leptothyra bacula* Carpenter)
**Homalopoma carpenteri* Pilsbry
*Homalopoma paucicostatum* Dall
**Hyalina* (*Cypraeolina*) *pyriformis* Carpenter
*Hyalina* (*Cystiscus*) *californica* Tomlin (*Marginella californica*)
*Hyalina* (*Cystiscus*) *jewettii* Carpenter
**Hyalina* (*Cystiscus*) *minor* C. B. Adams
**Hyalina* (*Cystiscus*) *politulus* Dall
**Hyalina* (*Cystiscus*) *regularis* Carpenter
**Hyalina* (*Cystiscus*) *subtrigona* Carpenter
**Lacuna marmorata* Dall
**Lacuna unifasciata* Carpenter
**Liotia acuticostata* Carpenter
**Liotia acuticostata bristolae* Baker
**Liotia fenestrata* Carpenter
*Littorina planaxis* Philippi
**Littorina scutulata* Gould
*Lottia gigantea* Gray
**Lucapinella callomarginata* Dall
*Macron kellettii* A. Adams
*Macron lividus* A. Adams
*Mangilia* (*Bela*) *interlirata* Stearns
*Mangilia* (*Mitromorpha*) *filosa* Carpenter
*Margarites acuticostatus* Carpenter
**Margarites parcipictus* Carpenter
*Megatebennus bimaculatus* Dall
*Melanella compacta* Carpenter
**Melanella micans* Carpenter
**Metaxia diadema* Bartsch
**Micranellum crebricinctum* Carpenter
**Mitrella aurantiaca* Dall (*Columbella aurantiaca* Dall)
**Mitrella carinata* Hinds
**Mitrella carinata gausapata* Gould
*Mitrella carinata hindsii* Reeve
*Mitrella tuberosa* Carpenter
*Nassarius fossatus* Gould
*Nassarius perpinguis* Hinds
**Norrisia norrisii* Sowerby
*Odostomia* (*Chrysallida*) *cincta* Carpenter
**Odostomia* (*Chrysallida*) *deceptrix* Dall & Bartsch
*Odostomia* (*Chrysallida*) *helga* Dall & Bartsch
**Odostomia* (*Chrysallida*) *lucca* Dall & Bartsch
**Odostomia* (*Chrysallida*) *pulcia* Dall & Bartsch
*Odostomia* (*Chrysallida*) *trachis* Dall & Bartsch
**Odostomia* (*Chrysallida*) *virginalis* Dall & Bartsch
*Odostomia* (*Evalea*) *californica* Dall & Bartsch
*Odostomia* (*Evalea*) *donilla* Dall & Bartsch
*Odostomia* (*Evalina*) *americana* Dall & Bartsch
*Odostomia* (*Iolaea*) *amianta* Dall & Bartsch
*Odostomia* (*Iolaea*) *eucosmia* Dall & Bartsch
**Odostomia* (*Ivara*) *turricula* Dall & Bartsch
**Odostomia* (*Ividella*) *navisa* Dall & Bartsch
**Odostomia* (*Menestho*) *amilda* Dall & Bartsch
*Odostomia* (*Menestho*) *fetella* Dall & Bartsch
**Odostomia* (*Miralda*) *aepynota* Dall & Bartsch
*Olivella biplicata* Sowerby
**Pedipes unisulcatus* Cooper
**Petaloconchus anellum* Mörch
**Petaloconchus complicatus* Dall
*Polinices uber* Valenciennes
*Purpura nuttalli* Conrad
*Retusa harpa* Dall
*Retusa* (*Acteocina*) *inculta* Gould
**Retusa* (*Acteocina*) *smirna* Dall

**Rimula mazatlanica* Carpenter
*?*Rissoella ?californica* Bartsch
**Rissoina bakeri* Bartsch
**Rissoina cleo* Bartsch
*Rissoina coronadoënsis* Bartsch
*Schismope californica* Bartsch
**Seila montereyensis* Bartsch
*Surculites* (*Megasurcula*) *tryonianus* Gabb (*Cryptoconus tryonianus* Gabb)
**Syncera translucens* Carpenter
*Tegula funebralis* A. Adams
*Tegula mariana* Dall
**Teinostoma invallata* Carpenter
**Teinostoma supravallata* Carpenter
**Tricolia pulloides* Carpenter
**Tricolia rubrilineata* Strong
*Tricolia substriata* Carpenter
*Triphora callipyrga* Bartsch
*Triphora catalinensis* Bartsch
*Tritonalia circumtexta* Stearns
*Tritonalia gracillima* Stearns
**Truncatella californica* Pfeiffer
**Truncatella stimpsoni* Stearns
**Turbonilla* (*Bartschella*) *laminata* Carpenter
**Turbonilla* (*Chemnitzia*) *hypolispa* Dall & Bartsch
**Turbonilla* (*Pyrgiscus*) *tenuicula* Gould
**Turbonilla* (*Strioturbonilla*) *buttoni* Dall & Bartsch
*Vermicularia eburnea* Reeve
**Vitrinella oldroydi* Bartsch
*Williamia peltoides* Carpenter

## AMPHINEURA

*Callistochiton crassicostatus* Pilsbry
*Callistochiton infortunatus* Pilsbry
*Ischnochiton conspicuus* Carpenter
*Ischnochiton magdalenensis* Hinds
*Ischnochiton mertensii* Middendorff
*Ischnochiton sarcosus* Dall
**Lepidochiton hartwegii* Carpenter
*Lepidopleurus percrassus* Dall
*Mopalia muscosa* Gould

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**No. 13**

# A RECORD OF THE FOSSIL GREBE, COLYMBUS PARVUS, FROM THE PLIOCENE OF CALIFORNIA, WITH REMARKS ON OTHER AMERICAN FOSSILS OF THIS FAMILY*

BY

ALEXANDER WETMORE
*Assistant Secretary, Smithsonian Institution*

The cores obtained during the drilling of wells have long been productive of invertebrate fossils, and have yielded many important specimens. Rarely bones of vertebrates have been found, some of them of definite importance, and now I have the pleasure of placing on record the first specimen of a fossil bird from such a source.

Dr. G. Dallas Hanna of the California Academy of Sciences has placed in my hands for study the excellently preserved distal end of a right tibio-tarsus of a bird found by Mr. W. D. Cortright of the Associated Oil Company in April, 1935 in a drill core obtained in Kern County, California. The specimen was obtained at a depth of 2318 to 2328 feet in the Standard Oil Company Well, Title Guaranty and Trust No. 1, located in Sec. 1, T 25 S., R 23 E., M.D.B. and M. The formation is the Tulare (freshwater) Pliocene,[1] about 120 feet above the first *Mya* Zone. The surface at the site is 215 feet above sea level.

The specimen is in excellent condition and represents a grebe of medium size whose identification has been a matter of considerable interest. In working with it I have had the benefit of the loan of

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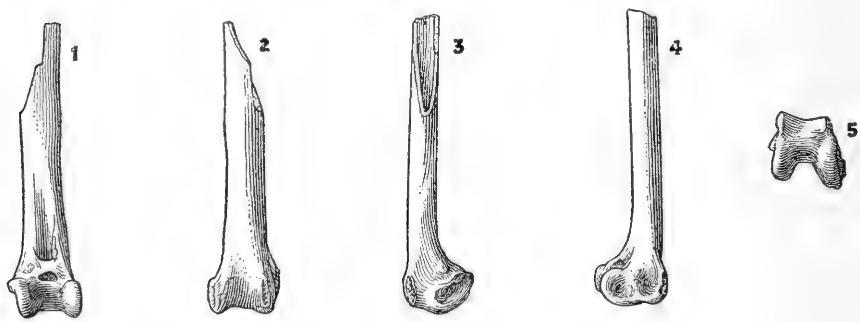
[1] For confirmation of the Pliocene age of the Tulare formation see: H. A. Pilsbry, Mollusks of the fresh-water Pliocene beds of the Kettleman Hills and neighboring oil fields, California. Proc. Acad. Nat. Sci. Philadelphia, vol. 86, Jan. 29, 1935, pp. 541–570, pls. 18–23, 2 text figs.

modern skeletons of Holboell's grebe from Dr. J. Grinnell of the Museum of Vertebrate Zoology of the University of California, and from Dr. Hildegarde Howard of the Los Angeles Museum of History, Science and Art. Additional fossil material is acknowledged below. Illustrations for this account have been prepared for me by Mr. Sydney Prentice.

The Pliocene tibio-tarsus is similar to that of the living Holboell's grebe *Colymbus grisegena holboelli* but is appreciably smaller. The inner side of the shaft is also more compressed at the lower end.




Figs. 1–5. Distal end of tibio-tarsus of *Colymbus parvus* Shufeldt, from Pliocene of California, approximately natural size.

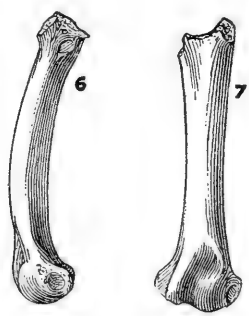
Following is a detailed description (see figures 1-5): Outline of external condyle, viewed laterally, irregularly rounded, with a distinct indentation in lower margin toward the rear; whole condyle considerably flattened and produced anteriorly; external face pitted and corrugated by points and depressions for tendinal attachments; internal condyle, viewed laterally, with lower margin distinctly impressed near center, produced anteriorly as a projecting plate with semicircular outline; on external surface a raised tubercle separating two rounded depressions symmetrically located in the anterior and posterior halves; intercondylar sulcus fairly broad, the intercondylar fossa deeply impressed; internal condyle rising from this as a narrow plate, the external condyle being much heavier; supra-tendinal bridge broad and strong, placed at an abrupt angle with the axis of the shaft; distal end of shaft broad and flattened; groove leading to tendinal bridge broad, occupying about one-half of width of shaft, with a sharp edged tubercle on internal margin at lower end; anterior face of shaft flattened; posterior face rounded, the lateral margins making a fairly sharp angle with the anterior face. Specimen well fossilized, dark brown in color, becoming grayish on articular surface.

Measurements are as follows: Smallest transverse breadth of shaft 4.7 mm., transverse breadth across condyles 9.0 mm., anterior-posterior diameter of inner condyle 8.6 mm., and of outer condyle 9.2 mm.

From careful comparison it appears that this fossil belongs in the genus *Colymbus*, and that it differs from any of the living species of that genus in its relative size. So far as may be judged from this fragmentary bone it was rather similar to the Holboell's grebe and its European relatives, being slightly smaller in dimensions.

Among fossil species from America close comparison has been made first with *Colymbus oligoceanus* Shufeldt,[2] named from a fragmentary femur assigned questionably to the Oligocene (John Day). Through the kindness of Dr. Richard S. Lull and Dr. Malcom R. Thorpe I have been permitted to make a careful study of this type, which is preserved in the Peabody Museum at Yale University.

The specimen, Cat. No. 983 (HT), Peabody Museum, Yale University, from Lower Willow Creek, Baker County, Oregon, consists of the shaft of a left femur, strongly fossilized and slaty black in color. The proximal end is missing and the distal end is broken and eroded, so that most of the characters of the articular surface are lost (figures 6-7).




Figs. 6–7. Type of *Colymbus oligoceanus* Shufeldt, fragmentary femur, approximately natural size.

As Dr. Shufeldt did not illustrate the type of *C. oligoceanus*, it is pertinent to give a more detailed description, taken directly from the type specimen: Shaft viewed from the side, definitely curved in outline, somewhat compressed from side to side near the center; proximal end slightly expanded to support the head and trochanter (which are missing), flattened on lower surface; an irregular line for muscle attachment indicated on lower surface; a rounded tubercle of low elevation placed externally to the rather narrow, poorly defined popliteal area; upper surface of shaft with a distinct impression above the rotular groove, becoming deep and triangular in outline on the external side. The condyles of the distal end are so eroded and

[2] Trans. Conn. Acad. Arts Sci., vol. 19, February, 1915, p. 54.

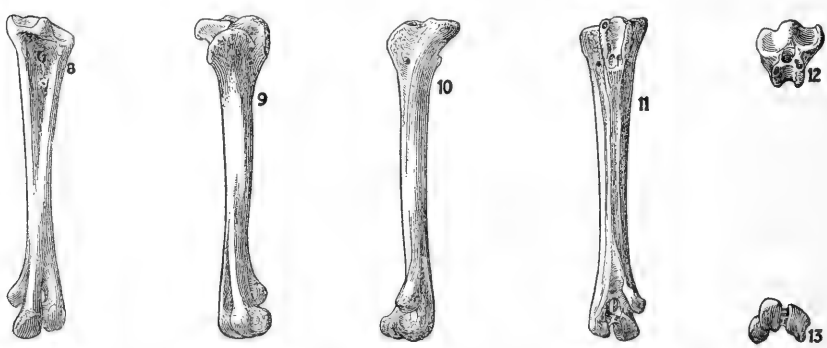
broken as to afford no characters of descriptive value. The transverse breadth of the shaft at its narrowest point measures 4.6 mm.

Because of its fragmentary condition the relationships of this bone are difficult to establish, but after prolonged examination I consider that it is properly allocated in the genus *Colymbus*. Among modern grebes it resembles the species of that group most closely in the amount of the lateral compression of the shaft, in the form of the popliteal area, and in the conformation of the lower surface at the anterior end. In *Aechmophorus* the shaft of the femur is relatively heavier and less compressed. *Podilymbus* has a greater arch in the curvature of the shaft, which also is more narrowed on the inner face at the distal end.

In size this fossil is somewhat less in length and is much more slender than modern *Colymbus grisegena holboelli*, while it is decidedly larger than modern *Colymbus nigricollis*. *Colymbus oligoceanus* from the femur, therefore, appears intermediate in dimension between the eared grebes and the Holboell's grebe, while the fossil tibiotarsus of *Colymbus* from the California Pliocene is only slightly smaller than Holboell's grebe. It seems that the California bird represents a larger species than *oligoceanus*, being intermediate between that species and living *Colymbus grisegena holboelli*.

Dr. Walter Granger of the American Museum of Natural History has allowed the study of two other fossil grebes described by Shufeldt, with results that are of value.

The first of these, *Podilymbus magnus* Shufeldt,[3] from the Pleistocene of Fossil Lake, Oregon, is based on two left metatarsi that are nearly complete, and a left coracoid. These are catalogued as No. 3574, and come from the Cope Collection.




Figs. 8–13. Type of *Podilymbus magnus* Shufeldt, approximately natural size.

The first of the metatarsi (figures 8-13) is practically complete, except that projecting angles are somewhat worn, and evidently

Bull. Amer. Mus. Nat. Hist., vol. 32, July 9, 1913, p. 136, pl. 38, figs. 439–440 and 449.

comes from an adult individual. It is well fossilized and is dark slate in color. The second, while entire, is somewhat more worn. It has the spongy appearance found in young birds in their first year when they have recently attained their maximum growth, and is obviously from an immature individual. This specimen is definitely brown in color. Measurements in millimeters of these two follow:

| | Number 1. | Number 2. |
|---|---|---|
| Total length | 43.8 | 42.7 |
| Transverse breadth of head | 8.7 | 8.1 |
| Transverse breadth across trochlea | 7.3 | 7.0 |
| Least transverse breadth of shaft | 3.6 | 3.2 |

Both, in contour and size, are identical with males of *Podilymbus podiceps* and are identified as that species, of which *Podilymbus magnus* Shufeldt becomes a synonym.

At the time that Shufeldt described *magnus* the only skeleton of the pied-billed grebe available to him in the National Museum collections was a female. As the female is much smaller than the male in this species, this evidently accounts for his error. The largest specimen now available, a male of *Podilymbus podiceps antarcticus* from Chile, in size exactly equals the first specimen of *magnus* mentioned above. Two males of *P. p. podiceps* are very slightly shorter than the fossil but the difference is so slight as to be considered an individual variation.

The coracoid included with the type material of *magnus* is similar in form to that of ordinary *Podilymbus podiceps*, though it is somewhat more slender than any that I have seen. It is however so closely approximated by some of the modern material available that I consider it to be from the pied-billed grebe. It measures 32.1 mm. in total length.

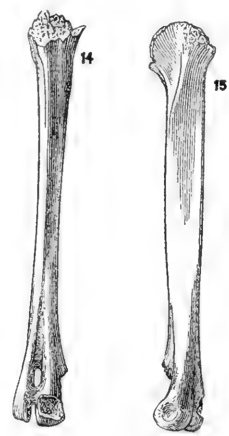
From the Cope collection Shufeldt named another grebe as *Colymbus parvus*[4] that presents a somewhat more complicated picture. The type material, American Museum of Natural History catalog No. 3570, includes the proximal portions of two humeri, two metatarsi lacking the head, and five coracoids.

The humeri, which are well fossilized, are easily identified as small examples of the American coot *Fulica americana*. One of the metatarsi comes from the same species, being from an immature individual as shown by the porous, lined condition of the bone. This specimen has the trochlea intact, and the head completely missing.

Three of the coracoids, being those shown in figures 481, 482 and 483 on plate 39 of Shufeldt's paper, are considerably worn, with parts of the slender projecting processes missing. They come from ducks of the genus *Querquedula*. While the slender form of the shaft resembles what is found in the blue-winged teal, *Querquedula discors*, they are too incomplete to warrant definite specific variation.

[4] Bull. Amer. Mus. Nat. Hist., vol. 32, July 9, 1913, p. 136, pl. 39, figs. 474–477, 481–483.

This leaves one right metatarsus and two coracoids (the latter not figured by Shufeldt) which are from a grebe. The metatarsus is hereby selected as the type specimen of *Colymbus parvus* (see figures 14-15). The specimen is illustrated by Shufeldt in figure 477, plate 39 of the original description. This bone has the inner trochlea and the proximal part of the head missing. It is dark slate in color and is well fossilized, coming from an adult individual. Part of the hypotarsus still remains on the posterior face of the upper end of the shaft.




Figs. 14–15. Type of *Colymbus parvus* Shufeldt, approximately natural size.

On careful comparison it develops that this specimen is similar to *Colymbus g. holboelli*, differing in slightly smaller size. The two trochleae that are present are relatively smaller and slighter, and the shaft is more compressed than in the modern form. Following are pertinent measurements: Length from lower end of hypotarsus 47.0 mm., least transverse diameter of shaft 3.0 mm.

This type of *C. parvus* bears the same size relation to a series of five metatarsi of living *C. g. holboelli* that the fragmentary tibiotarsus from the Pliocene drill core does to the tibio-tarsi of the same birds.

The correlation of the two fossils in size and type is so definite that no point of divergence between them can be found. In view of this I have designated the tibio-tarsus from California as a second specimen of *Colymbus parvus* Shufeldt. This species is therefore carried back in its history into the Pliocene, a matter that is entirely to be expected.

The two coracoids included in the type material of *parvus* are slightly smaller than those of the Holboell's grebe, bearing the same relation to that species as the metatarsus that accompanies them. They are therefore accepted as from *Colymbus parvus*.

According to data supplied by Dr. Hanna the age of the Tulare Lake beds, from which the tibio-tarsus of *Colymbus parvus* comes, is considered Upper Pliocene. The presence of a fossil grebe in these deposits of freshwater origin is of interest, while the manner in which the specimen was recovered is most intriguing. With this first specimen of a bird from a drill core at hand, further interest will attach to the possibility of securing more material from such sources.

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No. 14

# NEW SPECIES OF WEST AMERICAN SHELLS *

BY

A. M. STRONG

Mention was made in the lists of marine Mollusca of Guadalupe Island,[1] and the Tres Marias Islands, Mexico,[2] of a number of species which might prove to be undescribed. It is the purpose of the present paper to record some of these.

The material from Guadalupe Island was dredged by G. D. Hanna, E. K. Jordan and J. R. Slevin from a small patch of sandy bottom in the semi-sheltered cove at the south end of the island in from 9 to 15 fathoms. All of the species from there that appear to be new are fully described herein; they were given by genus-name only in the faunal list. The material from the Tres Marias Islands was dredged by G. D. Hanna off the east side of Maria Madre Island in front of the penal settlement in from 10 to 25 fathoms. Of the new species in this material only those belonging to the groups already reviewed in the papers by Baker, Hanna and Strong published by the Academy, are considered.

In addition, a new species from San Martin Island, off the west coast of Lower California, is included. It is the only new species

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* Printed from the John W. Hendrie Publication Endowment.

[1] Strong, A. M., and G. D. Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 19, no. 1, 1930.

[2] Strong, A. M., and G. D. Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 19, no. 3, 1930.

found in drift material collected by G. D. Hanna and E. K. Jordan at that locality. Three other species, one from Socorro Island and two from the Gulf of California, are included.

### 1. **Turbonilla (Careliopsis) hannai** Strong, new species

Plate 15, figure 3

Shell very slender, elongate conic, translucent, yellowish-white; nuclear whorls about two, smooth, polished, forming an elevated helicoid spire, whose axis is at right angles to that of the succeeding whorls and from which it is separated by a sharp line; postnuclear whorls well rounded, very slightly shouldered at the summit, moderately contracted at the suture, marked with fine, incised, spiral lines of which 8 appear on the second whorl, 12 on the fourth, 14 on the sixth, and 16 on the penultimate whorl, between the sutures; axial ribs only faintly indicated by occasional swellings; periphery of last whorl well rounded; base moderately long, well rounded, marked with a few, incised, spiral lines similar in spacing to those on the spire but much fainter; aperture oval, outer lip thin, columella short, strongly curved, without visible fold at the insertion. The type has 8 postnuclear whorls and measures: length, 5.1 mm.; diameter, 0.9 mm.

*Holotype:* No. 5828, Calif. Acad. Sci. Paleo. Type Coll., dredged in from 10 to 25 fms. off **Maria Madre Island, Tres Marias group, Mexico.** Twelve additional specimens were secured at the same place.

The species differs from *Turbonilla* (*Careliopsis*) *stenogyra* Dall and Bartsch,[3] the only other West Coast species described in the subgenus, in its more slender, conical shape and more feeble indications of axial ribs, which can hardly be said to pit the incised spiral lines.

The species is named for Dr. G. D. Hanna, who, with E. K. Jordan, collected the material.

### 2. **Turbonilla (Pyrgiscus) madriella** Strong, new species

Plate 15, figure 4

Shell slender, elongate-conic, flesh color; nuclear whorls two, smooth, translucent, having their axis at right angles to the succeeding whorls, in the first of which they are slightly immersed; postnuclear whorls very slightly rounded, roundly shouldered at the summit, and slightly contracted at the suture; marked with strong, almost vertical, axial ribs, of which 12 appear on the second whorl, 14 on the fourth, 16 on the sixth, 20 on the eighth, 24 on the tenth, and 30 on the penultimate whorl; interspaces a little narrower than the ribs, marked with 6 incised, spiral lines, which are very faint on the upper whorls, but gradually increase in strength until, on the penultimate whorl, they appear as narrow pits; periphery well rounded, marked by a narrow, flat space; base short, well rounded, marked with 6 strong, incised, spiral

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[3] Dall, W. H., and P. Bartsch, Bulletin 68, U. S. Nat. Mus., 1909, p. 130.

lines which grow gradually weaker and closer spaced from the periphery to the umbilical region, the first two below the peripheral band being pitted by the feeble continuation of the axial ribs; aperture oval, outer lip thin, showing the external sculpture within; columella slender, curved; parietal wall covered with a strong callus. The type has 12 postnuclear whorls and measures: length, 7.0 mm.; diameter, 1.7 mm.

*Holotype:* No. 5815, Calif. Acad. Sci. Paleo. Type Coll., dredged in from 10 to 25 fms. off **Maria Madre Island, Tres Marias group, Mexico.** Seventy additional specimens were secured at the same place.

This is one of the largest species in the subgenus, and is slightly larger than any previously reported from the Gulf of California region.

### 3. **Odostomia (Salassia) hertleini** Strong, new species

Plate 15, figure 9

Shell minute, pupiform, translucent, bluish-white; nuclear whorls two, smooth, slightly obliquely immersed in the first of the succeeding whorls; early postnuclear whorls rounded, the last flattened, scarcely contracted at the suture, closely appressed at the summit, the basal portion of the preceding whorl shining through the succeeding whorl, giving, in some lights, the appearance of a false suture or spiral groove; the whorls marked with 12 rounded, slightly protractive, axial ribs with shallow interspaces; on the early whorls these ribs are strong, reaching from suture to suture, but on the last whorl they are only feebly indicated at the summit; periphery rounded; base rather long, rounded, imperforate, marked with a few, faint, axial lines indicating the position for the extension of the axial ribs; aperture oval, posterior angle acute; outer lip thin, straight, basal lip slightly effuse, curving rather sharply into the outer lip and columella; columella slender, curved, with a weak fold at its insertion; parietal wall with a thin callus. The type has 6 postnuclear whorls and measures: length, 2.7 mm.; diameter, 0.8 mm.

*Holotype:* No. 5811 Calif. Acad. Sci. Paleo. Type Coll., dredged in from 10 to 25 fms. off **Maria Madre Island, Tres Marias group, Mexico.** Fifteen additional specimens were secured at the same locality.

While this species lacks both the tabulated summit to the whorls and the axial ribs extending to the umbilical region called for in Bartsch's description of the subgenus *Salassia* De Folin,[4] it clearly belongs to a natural group containing *Odostomia scalariformis* Carpenter[5] and *Odostomia gabrielensis* Baker, Hanna & Strong,[6] both of which have been placed in this subgenus. The present species differs from both in the number and character of the axial ribs.

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[4] See Dall, W. H., and P. Bartsch, Bulletin 68, U. S. Nat. Mus., 1909, p. 13, 134.

[5] Carpenter, P. P., Cat. Maz. Shells, 1857, p. 413.

[6] Baker, F., Hanna, G. D., and A. M. Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 17, 1928, p. 227, 228.

The species is named for Dr. Leo George Hertlein, Department of Paleontology, California Academy of Sciences.

### 4. **Odostomia (Evalea) martinensis** Strong, new species

Plate 15, figure 10

Shell minute, broadly ovate, semi-translucent, bluish-white; nuclear whorls very deeply immersed in the first of the postnuclear whorls; postnuclear whorls inflated, very strongly rounded, marked with faint, retractive lines of growth, and fine, incised, spiral lines, of which 4 appear on the first whorl, 6 on the second, and 8 on the penultimate whorl between the sutures; periphery of the last whorl inflated, well rounded; base short, well rounded, marked like the spire with incised spiral lines, which become finer and closer spaced toward the narrow, open, umbilicus; aperture broadly ovate; columella short, curved, provided with a fold at its insertion. The type has 4 postnuclear whorls and measures: length, 1.5 mm.; diameter, 1.1 mm.

*Holotype:* No. 5813, Calif. Acad. Sci. Paleo. Type Coll., collected in beach drift at **San Martin Island, off Lower California, Mexico.** Eight additional specimens were collected at the same place by G. D. Hanna and E. K. Jordan.

This minute species is well characterized by the broad form, distinct spiral sculpture, and open umbilicus.

### 5. **Cerithiopsis guadalupensis** Strong, new species

Plate 16, figure 6

Shell minute, broadly conic, chestnut brown; nuclear whorls two, smooth, well rounded, white, forming a minute, blunt apex; postnuclear whorls slightly rounded, high between the sutures, with both spiral and axial sculpture; spiral sculpture of three cords, of which one is at the summit, one a little above the periphery, and a median cord, which is much nearer the cord at the summit than the suprasutural cord; of these the cord at the summit is the weakest on all whorls, while the other two are about of equal strength; axial sculpture of almost vertical ribs, which are about as strong as the spiral cords, of which 12 appear on the first postnuclear whorl, 14 on the second, and 16 on the remainder of the whorls; intersection of the axial ribs and spiral cords forming strong tubercules, which are slightly truncated on the posterior margins; the spaces between the axial ribs and the median and suprasutural cords forming squarish pits, while those between the axial ribs and the median cord and the cord at the summit form spirally elongate pits; periphery of the last whorl marked by a strong, spiral cord, which is separated from the suprasutural cord by a sulcus as wide as that which separates the suprasutural cord from the median cord, and is rendered slightly waved by the feeble continuations of the axial ribs; base rather short, concave, without visible sculpture; aperture strongly channeled anteriorly; outer lip waved by the external sculpture (the edge broken in the type); columella short and stout; parietal wall covered with a thin callus. The type has 5 postnuclear whorls and measures: length, 2.3 mm.; diameter, 1.0 mm.

*Holotype:* No. 5810, Calif. Acad. Sci. Paleo. Type Coll., dredged in from 9 to 15 fms. off **Guadalupe Island, Mexico.** Fourteen additional specimens were secured at the same place by Messrs. Hanna; Jordan and Slevin.

While it is probable that none of the specimens may be fully mature, this would seem to be one of the smallest species described from the West Coast.

### 6. **Cerithiopsis anaitis** Bartsch

*Cerithiopsis anaitis* Bartsch, The Nautilus, vol. 31, 1918, p. 72.

*Cerithiopsis helena* Bartsch, Proc. U. S. Nat. Mus., vol. 52, 1917, p. 670, pl. 46, fig. 2.—Oldroyd, Stanford Univ. Publ. Geol. Sci., vol. 2, pt. 2, 1927, p. 216, pl. 67, fig. 2; [called "*Odostomia*" *helena* Bartsch].

Ten specimens, dredged in from 10 to 15 fathoms off Maria Madre Island, Tres Marias group, Mexico, seem to belong to this minute species. They agree very closely with the description and figure in all characters, except the color, which is uniformly brown. If correctly identified this is a widely distributed species as it has previously been reported from Panama Bay only.

### 7. **Diastoma slevini** Strong, new species

Plate 15, figure 2

Shell elongate conic, brownish; nuclear whorls a little over one, tilted at a slight angle, waxen, sculptured with a slender, spiral keel; early postnuclear whorls with a broad, sloping shoulder, later whorls moderately convex; spiral sculpture of fine, irregular, and irregularly spaced, raised threads, of which 2 appear on the first postnuclear whorl, 5 on the second, and gradually increasing in number until, on the penultimate whorl, about 20 appear between the sutures; axial sculpture on the early whorls of weak ribs or undulations, very irregular in strength and number, on the later whorls these become very faint, except for occasional indications of varix-like swellings; periphery and base well rounded, marked like the spire with about 10 spiral threads; aperture ovate, effuse, with a broad, shallow, anterior canal, interior yellowish, with a brown, spiral band anteriorly and a brown patch at the posterior angle; outer lip thin; columella short, twisted; parietal wall covered with a thick, brown callus. The type has 9 postnuclear whorls and measures: length, 7.6 mm.; diameter, 2.2 mm.

*Holotype:* No. 5809, Calif. Acad. Sci. Paleo. Type Coll., dredged in from 9 to 15 fms. off **Guadalupe Island, Mexico.** One hundred and eighty additional specimens were secured at the same place, including many young.

The species is named for Mr. Joseph R. Slevin, who, with G. D. Hanna and E. K. Jordan, made the collection at Guadalupe Island.

## 8. **Alabina jordani** Strong, new species

Plate 16, figure 9

Shell small, elongate conic, yellowish-white, variously blotched and lined with brown; nuclear whorls 2, smooth, rounded, white; postnuclear whorls sculptured with 4 spiral cords and numerous axial ribs; on the first two whorls the upper 2 and the 4th spiral cords are very feeble, while the 3rd forms a sharp keel, angulating the whorls; beginning with the third whorl the lower spiral cord begins to gradually increase in strength until, on the penultimate whorl, it equals the third, the first 2 cords, of which the upper is immediately below the suture, also gradually increase in strength on the later whorls, but are always weaker than the lower 2; the axial ribs begin to appear on the third whorl, and gradually increase in strength until on the penultimate whorl, where they number 16, they are nearly as strong as the 2 principal, spiral cords; the intersection of the spiral cords and axial ribs form spirally elongate nodules, which are sharply truncated on the posterior face; periphery marked by a sulcus about as wide as the spaces between the spiral cords; base short, slightly convex, marked with 5 spiral cords, of which the first and strongest, immediately below the sulcus, is slightly waved by the feeble continuations of the axial ribs, while the others become gradually weaker toward the umbilical region; aperture ovate, slightly channeled anteriorly; outer lip thin, showing the external sculpture within; columella short, oblique; parietal wall covered with a thin callus. The type has 7 postnuclear whorls and measures: length, 5.0 mm.; diameter, 1.4 mm.

*Holotype:* No. 5818, Calif. Acad. Sci. Paleo. Type Coll., dredged in from 9 to 15 fms. off **Guadalupe Island, Mexico.** Sixty-seven additional specimens were secured at the same place.

The species is named for the late Mr. E. K. Jordan, who, with G. D. Hanna and J. R. Slevin, made the collection at Guadalupe Island.

## 9. **Rissoina guadalupensis** Strong, new species

Plate 15, figure 7

Shell small, elongate conic, subdiaphanous, white; nuclear whorls a little over two, comparatively large, smooth, well rounded, the first forming a minute, blunt apex; postnuclear whorls moderately rounded, very slightly shouldered at the summit; axial sculpture of 20 slender, straight, protractive ribs, which are not quite as wide as the spaces which separate them, and extend over the base to the umbilical region; spiral sculpture of very numerous, sharp striations, which are most prominent in the interspaces between the axial ribs; periphery and base well rounded, sculptured like the spire; aperture effuse, thickened at the edge; inner lip slender, curved; parietal wall with a moderately thick callus. The type has 7 postnuclear whorls and measures: length, 4.0 mm.; diameter, 1.5 mm.

*Holotype:* No. 5812, Calif. Acad. Sci. Paleo. Type Coll., dredged in from 9 to 15 fms. off **Guadalupe Island, Mexico.** Twenty-five additional specimens were secured at the same place.

This belongs to the group of minute, thin, white species ranging from the Santa Barbara Islands, California, to San Martin Island, Mexico, in which Bartsch has described five species: *R. cleo*, *R. dalli*, *R. californica*, *R. bakeri*, and *R. coronadoensis*.[7] The present species differs from all of them in the presence of the distinct spiral sculpture.

### 10. **Rissoina lowei** Strong, new species

Plate 16, figure 7

Shell cylindro-conic, varying from pale yellowish to dark brown, unicolor, or in broad, spiral bands; nuclear whorls two, smooth, well rounded, the first forming a comparatively large, blunt apex; postnuclear whorls moderately rounded, slightly shouldered at the summit; spiral sculpture of fine, close-spaced threads, of which 5 show on the first whorl, 8 on the second, 12 on the third, and 16 on the penultimate whorl between the sutures; in addition to this spiral sculpture the first two whorls are marked with 16, low, rounded, axial undulations which are faintly indicated on the third whorl, but entirely absent from the rest of the shell; periphery well rounded; base moderately long, well rounded, marked with 8 spiral threads similar to those on the spire; aperture ovate; outer lip very little thickened, the edge finely serrated by the spiral threads; columella short, thin, strongly curved; parietal wall covered with a thin callus. The type has 5 postnuclear whorls and measures: length, 4.5 mm.; diameter, 1.8 mm.

*Holotype:* No. 5814, Calif. Acad. Sci. Paleo. Type Coll., dredged in from 9 to 15 fms. off **Guadalupe Island, Mexico.** Two hundred and twenty additional specimens, including many young, were secured at the same place.

This belongs to the well marked group of west coast species with colored shells and faint axial sculpture, containing *R. kelseyi* Dall and Bartsch,[8] from Southern California and *R. lapazana* Bartsch,[9] *R. berryi* Baker, Hanna and Strong,[10] and *R. stephensæ*[11] Baker, Hanna and Strong from the Gulf of California. From the first three it differs in the much smaller size, as well as in the details of the sculpture, and from the last in the rounded periphery and more numerous spiral threads.

The species is named for the late Mr. H. N. Lowe, well known collector of mollusks.

### 11. **Rissoina willetti** Strong, new species

Plate 15, figure 6

Shell small, elongate conic, subdiaphanous, white; nuclear whorls nearly two, small, well rounded; postnuclear whorls well rounded, very slightly shouldered at the summit; axial sculpture of 12 strong, nearly straight, protractive ribs, separated

[7] Bartsch, P., Proc. U. S. Nat. Mus., vol. 49, 1915, pp. 55–60.

[8] Dall, W. H., and P. Bartsch, The Nautilus, vol. 16, 1902, p. 94.

[9] Bartsch, P., Proc. U. S. Nat. Mus., vol. 49, 1915, p. 50.

[10] Baker, F., Hanna, G. D., and A. M. Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 19, no. 4, 1930, p. 35.

[11] Baker, F., Hanna, G. D., and A. M. Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 19, no. 4, 1930, p. 33.

by spaces about twice as wide as the ribs which terminate at the periphery; spiral sculpture absent; periphery marked by a slender spiral thread; base short, concave anteriorly, marked with very feeble continuations of the axial ribs; aperture effuse, outer lip much thickened; columella short, curved; parietal wall covered with a thin callus. The type has 6 postnuclear whorls and measures: length, 2.9 mm.; diameter, 1.1 mm.

*Holotype:* No. 5829, Calif. Acad. Sci. Paleo. Type Coll., dredged in from 9 to 15 fms. off **Guadalupe Island, Mexico.** Seventy additional specimens were secured at the same place.

This differs from all species described from the West Coast in having an almost smooth base with the ribs terminating at the periphery.

The species is named for Mr. George Willett, Curator of Ornithology, Los Angeles County Museum of Science, History and Art.

## 12. **Alvania granti** Strong, new species

Plate 15, figure 8

Shell small, elongate conic, yellowish-white; nuclear whorls 2, smooth, well rounded; postnuclear whorls rounded, shouldered at the summit, separated by a deep suture; axial sculpture of sharp, almost vertical ribs, of which 12 appear on the first and second whorls and 14 on the remaining whorls; spiral sculpture of equally strong cords, of which 2 appear on the first and second whorls, one at the summit and the other a little above the suture, on the third whorl a slightly smaller cord appears between the first two, followed by other, intercalary cords until, on the penultimate whorl, there are 6 cords between the sutures, all of about equal strength; the junction of the axial ribs and spiral cords form strong tubercules, while the interspaces vary from deep, squarish pits on the upper whorls to narrow, spirally elongate pits in the last whorl; periphery of the last whorl marked by a narrow sulcus; base moderately rounded, produced anteriorly, marked by 6 strong, spiral cords, the one immediately below the peripheral sulcus being rendered tuberculate by feeble extensions of the axial ribs; aperture oblique, oval, posterior angle obtuse; outer lip thickened by a varix just back of the edge; inner lip short, curved; parietal wall covered by a thick callus. The type has 5 postnuclear whorls and measures: length, 2.8 mm.; diameter, 1.1 mm.

*Holotype:* No. 5825, Calif. Acad. Sci. Paleo. Type Coll., dredged in from 10 to 25 fms. off **Maria Madre Island, Tres Marias group, Mexico.** Seventy-five additional specimens were secured at the same place.

The sculpture of this species seems to be quite similar to that of *Alvania effusa* Carpenter,[12] from Mazatlan, if the figure given by Bartsch:[13] "after a camera lucida sketch by Dr. Carpenter," can be depended upon. However, that figure shows more numerous axial ribs and spiral cords than are found on the present species.

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[12] Carpenter, P. P., Cat. Maz. Shells. 1857, p. 359.

[13] Bartsch, P., Proc. U. S. Nat. Mus., vol. 41, 1912, p. 358, pl. 32, fig. 5.

The species is named for U. S. Grant IV, Associate Professor of Paleontology, University of California at Los Angeles.

### 13. **Alvania herreræ** Baker, Hanna & Strong

*Alvania herreræ* Baker, Hanna & Strong, Proc. Calif. Acad. Sci., ser. 4, vol. 19, 1930, pp. 25, 26.

Twenty-five specimens of this species were dredged in from 10 to 25 fms. off Maria Madre Island of the Tres Marias group, Mexico. This adds considerably to the range; the species was described from Cape San Lucas.

### 14. **Rissoella (?) bakeri** Strong, new species

Plate 15, figure 5

Shell small, thin, broadly ovate, semitranslucent, bluish-white; nuclear whorls hardly differentiated from the postnuclear whorls; whorls inflated, well rounded; sculpture consisting of fine, close-spaced, incised, spiral lines of which 6 appear on the second whorl and 12 on the third whorl, the spacing continuing about the same over the body whorl and base; the spaces between the first 3 incised, spiral lines below the suture and the last 5 on the base are slightly raised, giving the appearance of spiral threads; periphery and base well rounded; aperture broadly oval, posterior angle acute, angle at the junction of the basal and inner lip very obtuse; outer lip thin, inner lip strongly curved, expanded over the parietal wall, rendering the peritreme complete, the lower portion separated from the body whorl by a shallow groove leading to the small, open umbilicus. The type has 4½ whorls and measures: length, 2.2 mm.; diameter, 1.6 mm.

*Holotype:* No. 5821, Mus. Calif. Acad. Sci. Paleo. Type Coll., dredged in from 9 to 15 fms. off **Guadalupe Island, Mexico.** Six additional specimens were secured at the same place.

This species appears to belong to the same genus as *Rissoella* (?) *californica* Bartsch,[14] of which he says: "I am placing this species in the genus *Rissoella* with some doubt, but until I have seen anatomic material I hesitate to give it a distinct generic designation." The Academy specimens are also "dead" so the anatomic material is yet to be secured. The present species differs from *R. californica* in the stronger, spiral sculpture, smaller umbilicus and proportionally broader form. The general character of the shell agrees very well with those of the species listed and described in a preceding paper on "Some Rissoid Mollusca from the Gulf of California"[15] under the genus *Rissoella*.

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[14] Bartsch, P., Proc. U. S. Nat. Mus., vol. 70, art. 11, 1927, p. 31.

[15] Baker, F., Hanna, G. D., and A. M. Strong, Proc. Cal. Acad. Sci., ser. 4, vol. 19, no. 4, 1930, p. 36.

The species is named for Dr. Fred Baker, Point Loma, California.

### 15. **Colubraria jordani** Strong, new species

Plate 16, figure 8

*Epidromus nitidulus* Sowerby, Strong and Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 19, no. 2, 1930, p. 11. Socorro Island, Revillagigedo Islands. Not *Triton nitidulus* Sowerby.

*Colubraria jordani* Strong, (MS.), in Hertlein, Proc. Amer. Philos. Soc., vol. 78, no. 2, 1937, p. 306. Socorro Island, Revillagigedo Group; Galapagos Islands.

Shell slender, with two and a half nuclear whorls and eleven subsequent, sculptured whorls, light brown with two spiral rows of darker spots; each whorl with one or two varices; upper whorls with three fine, spiral threads, slightly nodulous where they cross equally fine, axial riblets, the sculpture becoming fainter on the later whorls; entire surface with microscopic, spiral striations; periphery of last whorl rounded, base short, rounded; outer lip thickened by a varix, inside with eight indistinct, spirally elongate denticles; body with a broad wash of callus, and a spiral rib just below the posterior end of the aperture; columella expanded; canal short, recurved. The type measures: length, 35 mm.; maximum diameter, 10 mm.

*Holotype:* No. 7017, Calif. Acad. Sci. Paleo. Type Coll., from Loc. 23776 (C. A. S.), **Socorro Island, Revillagigedo group, Mexico,**[16] G. D. Hanna and E. K. Jordan, collectors, July 1925. Seven additional specimens were secured at the same locality.

This west American species differs from *Colubraria nitidulus* Sowerby,[17] well known in the Indo-Pacific fauna, in being decidedly more slender, having more rounded whorls, and in the more emphatic sculpture. These differences appeared constant in a comparison with three lots of specimens of *C. nitidulus* from the Philippine Islands in the collection of the Leland Stanford Jr. University.

This species is named for Mr. Eric Knight Jordan, formerly Assistant Curator of Paleontology of the California Academy of Sciences.

### **Alleorus** Strong, new genus

Shell minute, depressed, spiral, with close-set spiral lines; umbilicus deeply rimate; aperture very oblique with a deep sinus-notch at the suture; shell growth about this sinus produces a series of sutural nodes, set oblique to the suture; apica whorl smooth and polished. Type, *Alleorus deprellus* Strong, new species.

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[16] Strong, A. M., and G. D. Hanna, Proc. Calif. Acad. Sci., ser. 4, vol. 19, no. 2, 1930, p. 7.

[17] *Triton nitidulus* Sowerby, Proc. Zool. Soc., 1833, p. 71, "*Hab.* ad Insulam Annaa." "Found on the reefs."—Reeve, Conch. Icon., vol. 2, 1844, *Triton*, species 70.

The combination of characters displayed by this mollusk has not been found in any described genus. It probably belongs to the Adeorbidæ but even this determination is not at all certain. The row of sutural beads is very striking and this position of a highly developed sinus is unusual, at least, in members of that family.

## 16. **Alleorus deprellus** Strong, new species

Plate 16, figures 3, 4, 5

Shell minute, depressed, composed of three slightly rounded whorls, the apical one, smooth and polished, the remaining two, finely spirally striate, crossed by low ridges parallel to growth lines; last whorl sharply carinate; base flattened, marked with fine, spiral lines as above; umbilicus deeply rimate, half covered within by a callus plate; aperture very oblique; peristome not thickened; parietal wall rounded and thickened; a deep sinus located at the suture line; at regular intervals during growth the callus deposit found about the sinus forms a retractive node; these are closely spaced forming a sutural row of beads, 24 being present on the last whorl; interiorly a deep, rounded groove follows the sutural line. Greatest diameter 2.06 mm.; least diameter 1.66 mm.; altitude .73 mm.

*Holotype:* No. 7075, Calif. Acad. Sci. Paleo. Type Coll., dredged by Fred Baker at **San Jose Island, Gulf of California,** in shallow water in 1921. *Paratype:* No. 7076, from the same locality.

The holotype appears to be adult. The paratype is somewhat smaller, but the characters shown do not differ otherwise than as described above. The row of beads following the suture makes this a very striking little shell, not even near to anything else we have been able to locate in the literature. Tentatively, it seems best to include it in the family Adeorbidæ.

## 17. **Glycymeris guadalupensis** Strong, new species

Plate 16, figures 1 and 2

Shell small, orbicular, thick and solid, moderately compressed, surface evenly reticulated with fine, close-spaced, radiating and concentric ridges; epidermis wanting; umbones small, close, projecting slightly above the hinge line, posterior and basal margins evenly rounded, anterior slightly angulated, hinge line straight; inner margin crenulated, cardinal area very narrow, with a small, chevron-shaped groove and two diagonal striations; hinge plate broad, strongly curved, the anterior side longer, with, in the type, eight strong teeth on each side; umbones and a varying sized area below them white; remainder of exterior brown, the line between the white and brown areas usually sharply defined in a ziz-zag pattern; interior white, stained with brown. The type and paratype, consisting of a right and a left valve of equal size, measure: length, 7.5 mm.; height, 7.0 mm.; diameter, 4.5 mm.

*Holotype:* No. 5822, and *paratype:* No. 5822A, Calif. Acad. Sci Paleo. Type Coll., dredged in from 9 to 15 fms. off **Guadalupe Island,**

**Mexico.** Thirty attached pairs, all young, and one hundred and forty single valves were secured at the same place.

The largest valve secured (paratype No. 5823) measures: length, 10 mm.; height, 10 mm. In general appearance the present species resembles *Glycymeris corteziana* Dall,[18] the type of which was dredged off Cortez Bank but it seems to be a much smaller shell differing somewhat in shape and sculpture.

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[18] Dall, W. H., Proc. U. S. Nat. Mus., vol. 52, 1916, p. 402.

Plate 15

Fig. 1. *Amphissa lyrta* Baker, Hanna and Strong, n. sp. Holotype, No. 5816, C. A. S. Paleo. Type Coll., Isla Partida, Gulf of California. Length, 9.0 mm.; diameter, 4 mm.; p. 252. (The description of this species will be found in Vol. XXIII, No. 16, p. 252; Baker, Hanna and Strong, Columbellidæ from Western Mexico).

Fig. 2. *Diastoma slevini* Strong, n. sp. Holotype, No. 5809, C. A. S. Paleo. Type Coll., Guadalupe Island, Mexico. Length, 7.6 mm.; diameter, 2.2 mm.; p. 207.

Fig. 3. *Turbonilla hannai* Strong, n. sp. Holotype, No. 5828, C. A. S. Paleo. Type Coll., Maria Madre Island, Mexico. Length, 5.1 mm.; diameter, 0.9 mm.; p. 204.

Fig. 4. *Turbonilla madriella* Strong, n. sp. Holotype, No. 5815, C. A. S. Paleo Type Coll., Maria Madre Island, Mexico. Length, 7.0 mm.; diameter, 1.7 mm.; p. 204.

Fig. 5. *Rissoella* (?) *bakeri* Strong, n. sp. Holotype, No. 5821, C. A. S. Paleo. Type Coll., Guadalupe Island, Mexico. Length, 2.2 mm.; diameter, 1.6 mm.; p. 211.

Fig. 6. *Rissoina willetti* Strong, n. sp. Holotype, No. 5829, C. A. S. Paleo. Type Coll., Guadalupe Island, Mexico. Length, 2.9 mm.; diameter 1.1 mm.; p. 209.

Fig. 7. *Rissoina guadalupensis* Strong, n. sp. Holotype, No. 5812, C. A. S. Paleo. Type Coll., Guadalupe Island, Mexico. Length, 4.0 mm.; diameter, 1.5 mm.; p. 208.

Fig. 8. *Alvania granti* Strong, n. sp. Holotype, No. 5825, C. A. S. Paleo. Type Coll., Maria Madre Island, Mexico. Length, 2.8 mm.; diameter, 1.1 mm.; p. 210.

Fig. 9. *Odostomia hertleini* Strong, n. sp. Holotype, No. 5811, C. A. S. Paleo. Type Coll., Maria Madre Island, Mexico. Length, 2.7 mm.; diameter, 0.8 mm.; p. 205.

Fig. 10. *Odostomia martinensis* Strong, n. sp. Holotype, No. 5813, C. A. S. Paleo. Type Coll., San Martin Island, Lower California, Mexico. Length, 1.5 mm.; diameter 1.1 mm.; p. 206.

## Plate 16

Fig. 1. *Glycymeris guadalupensis* Strong, n. sp. Holotype, a right valve, No. 5822, C. A. S. Paleo. Type Coll., Guadalupe Island, Mexico. Length, 7.5 mm.; height, 7.0 mm.; p. 213.

Fig. 2. *Glycymeris guadalupensis* Strong, n. sp. Paratype, No. 5822A, C. A. S. Paleo. Type Coll. Inside of left valve; p. 213.

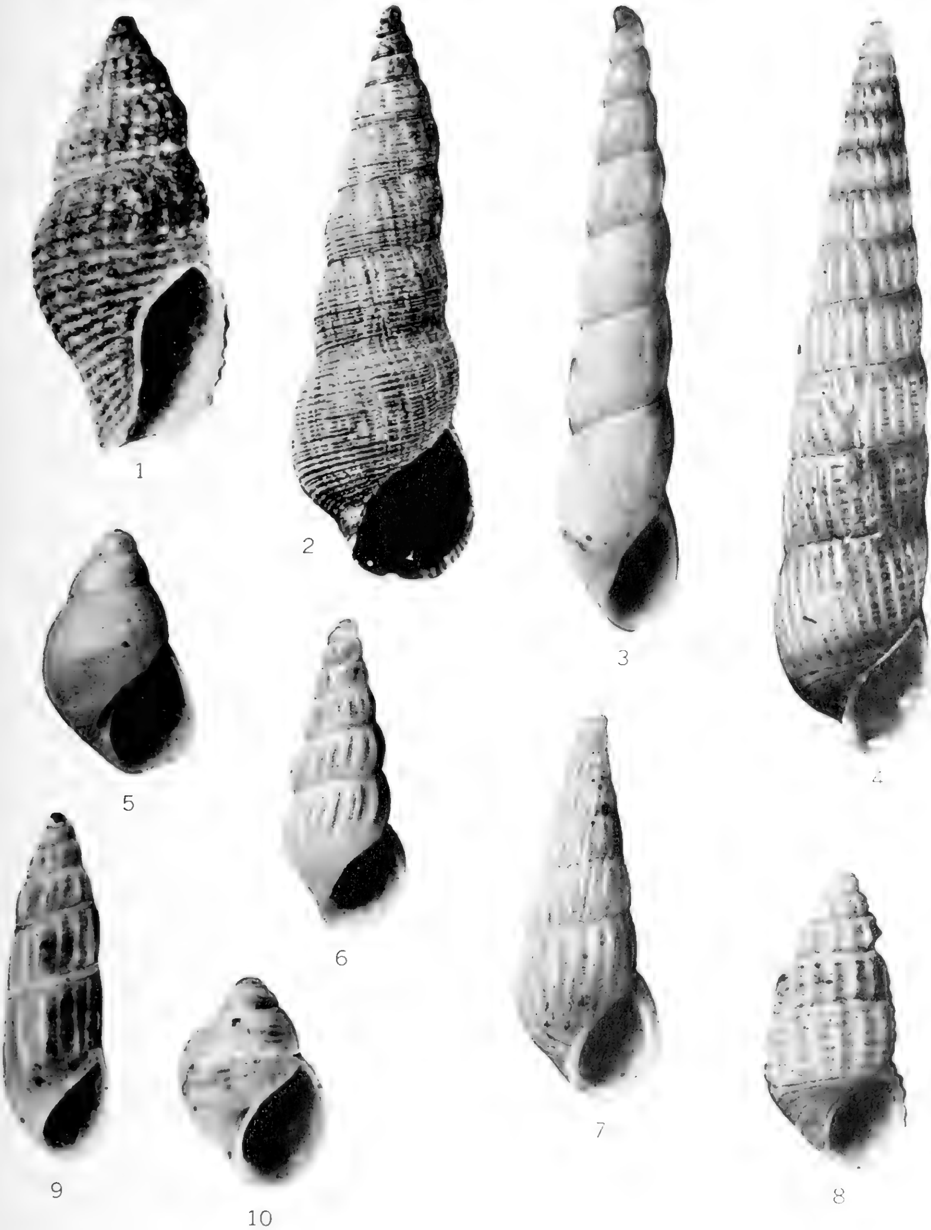
Figs. 3, 4, 5. *Alleorus deprellus* Strong, n. sp. Holotype, No. 7075, C. A. S. Paleo. Type Coll., San Jose Island, Gulf of California. Diameter, 2.06 mm.; altitude .73 mm.; p. 213.

Fig. 6. *Cerithiopsis guadalupensis* Strong, n. sp. Holotype, No. 5810, C. A. S. Paleo. Type Coll., Guadalupe Island, Mexico. Length, 2.3 mm.; diameter, 1.0 mm.; p. 206.

Fig. 7. *Rissoina lowei* Strong, n. sp. Holotype, No. 5814, C. A. S. Paleo. Type Coll., Guadalupe Island, Mexico. Length, 4.5 mm.; diameter, 1.8 mm.; p. 209.

Fig. 8. *Colubraria jordani* Strong, n. sp. Holotype, No. 7017, C. A. S. Paleo. Type Coll., Socorro Island, Revillagigedo Islands, Mexico. Length, 35 mm., maximum diameter 10 mm.; p. 212.

Fig. 9. *Alabina jordani* Strong, n. sp. Holotype, No. 5818, C. A. S. Paleo. Type Coll., Guadalupe Island, Mexico. Length, 5.0 mm.; diameter, 1.4 mm.; p. 208.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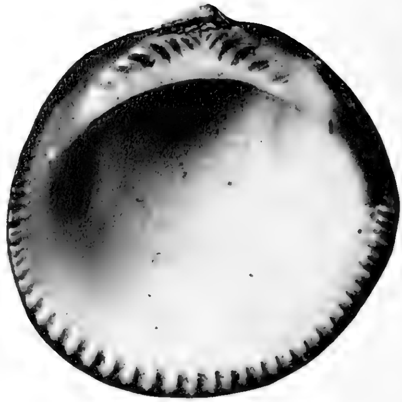

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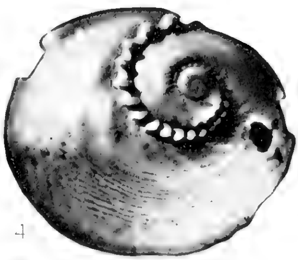

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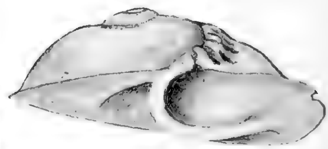

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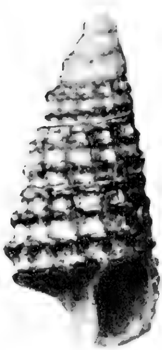

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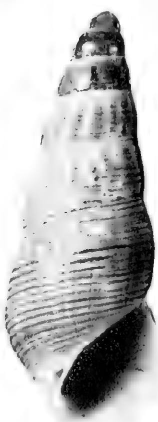

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**No. 15**

# SOME MOLLUSCA OF THE FAMILIES CERITHIOPSIDÆ, CERITHIIDÆ AND CYCLOSTREMATIDÆ FROM THE GULF OF CALIFORNIA AND ADJACENT WATERS*

BY

FRED BAKER
*San Diego, California*

G. D. HANNA
*Curator, Department of Paleontology*
*California Academy of Sciences*

AND

A. M. STRONG
*Los Angeles, California*

This report follows the general plan of preceding ones of the series of papers dealing with the marine mollusca of the Gulf of California and adjacent waters. Publication of the series began in 1923 in volume 13 of the Proceedings of the Academy, and it is expected that additional families will be treated from time to time. Various collections have been used in the preparation of the present contribution but the expeditions the Academy sent to the Gulf and west Mexican waters in 1921, 1922 and 1925 contributed the bulk of the material.[1]

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* Printed from the John W. Hendrie Publication Endowment.

[1] For itineraries of these expeditions see: SLEVIN, J. R., Proc. Calif. Acad. Sci., ser. 4, vol. 12, No. 6, 1923 pp. 55–72.—HANNA, G. D., op. cit., vol. 14, No. 12, 1925, pp. 217–275, pls. 15-19.—HANNA, G. D., op. cit., vol. 15, No. 1, 1926, pp. 1–113, pls. 1–10, 7 text figs.

## Family CERITHIOPSIDÆ

### 1. **Cerithiopsis (Cerithiopsis) grippi** Bartsch

*Cerithiopsis* (*Cerithiopsis*) *grippi* BARTSCH, Proc. U. S. Nat. Mus., vol. 52, 1917, p. 669, pl. 48, fig. 12.

Three specimens of this species were taken at Cape San Lucas, Lower California, and there is one in the Baker collection marked: "Gulf of California." Bartsch said in his original description: "The entire surface of the spire and the base is marked by very fine, incremental lines and much finer, spiral striations," but he failed to call attention to the fact that these lines cut the tubercles into quite well-defined sections, a characteristic of all specimens examined, including the type lot.

### 2. **Cerithiopsis (Cerithiopsis) oxys** Bartsch

*Cerithiopsis* (*Cerithiopsis*) *oxys* BARTSCH, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 332, pl. 36, fig. 2.

Taken at Agua Caliente and Cape San Lucas, Lower California.

### 3. **Cerithiopsis (Cerithiopsis) pupiformis** Carpenter

Plate 19, figure 1

*Cerithiopsis pupiformis* CARPENTER, Cat. Mazatlan Shells, 1857, pp. 443, 444.
*Cerithiopsis* (*Cerithiopsis*) *pupiformis* Carpenter, BARTSCH, Proc. U. S. Nat. Mus., vol. 40, 1911, pp. 337, 338, pl. 38, figs. 1, 5.

Three specimens from Cape San Lucas, Lower California, seem to agree fully with the description of this species.

### 4. **Cerithiopsis (Cerithiopsis) subgloriosa** Baker, Hanna and Strong, new species

Plate 18, figure 7

Shell of medium size, regularly elongate-conic, milk white; nuclear whorls 3¾, the first small, mammillary, the rest very convex, smooth, separated by impressed sutures, regularly increasing in size and merging gradually into the postnuclear whorls; postnuclear whorls 7½, the earlier turns convex, becoming flatter below, marked by three very prominent spiral cords, the posterior small at first but gradually becoming slightly the largest, crossed by equally prominent, slightly retractive axial ribs extending strongly to the peripheral cord and very feebly over the base, 16 appearing on the first turn, 18 on the second and 22 on the seventh, the spiral cords being sharply truncated anteriorly and posteriorly, rendering them distinctly rectangular between the tubercles; axial ribs more rounded, the intersections marked by roundish tubercles, truncated posteriorly and occasionally subcuspidate; spiral cords nearly equally spaced, the middle cord being slightly nearer the posterior than the anterior; spaces included between the spiral cords and axial ribs forming deep pits, generally irregular in shape but tending to become squarish on the anterior whorls; sutures deeply impressed but not channeled, crossed prominently by the axial ribs which are not continuous; periphery marked by a spiral cord similar to the anterior one on the last turn, but much narrower and sharply truncated anteriorly into the slightly concave base; base marked by a low, narrow spiral cord about midway between the peripheral cord and the umbilical region, and everywhere crossed by the obsolete continuations of the axial ribs; aperture irregularly oval; outer and basal lips thin, corrugated by the external sculpture; columella strong, nearly vertical, sharply revolute, slightly concave, moderately calloused, obtusely angled at the beginning of the anterior canal; anterior canal short, reflected at an angle of about 45°; parietal wall marked by an extension of the external sculpture. Length, 3.93 mm.; diameter, 1.19 mm.

*Holotype:* No. 5453, C. A. S. Paleo Type Coll., and a half grown specimen from **Amortajada Bay, San Jose Island, Gulf of California;** collected by Fred Baker, 1921; two specimens from La Paz, Lower California in about four fathoms, and one from the "Gulf of California" taken by Geo. D. Porter.

The species is closely related to *Cerithiopsis gloriosa* Bartsch, but it is colored differently, is proportionately smaller, lacks the extension of the peripheral keel into the preceding sutures, the middle keel is closer to the posterior keel than to the anterior one, the axial ribs are slightly retractive instead of slightly protractive and the intercostal pits are much less distinctly defined than in *C. gloriosa.* These differential characteristics are well marked in all specimens taken.

### 5. **Cerithiopsis (Cerithiopsis) tuberculoides** Carpenter

Plate 19, figure 3

*Cerithiopsis tuberculoides* Carpenter, Cat. Mazatlan shells, 1857, pp. 442, 443.
*Cerithiopsis (Cerithiopsis) tuberculoides* Carpenter, Bartsch, Proc. U. S. Nat. Mus., vol. 40, 1911, pp. 336, 337, pl. 37, fig. 7.

Taken in three or four fathoms at La Paz, and Cape San Lucas, Lower California, and at Isthmus Bay, Espiritu Santo Island, Gulf of California.

### 6. **Cerithiopsis (Cerithiopsida) bristolæ** Baker, Hanna and Strong, new species

Plate 19, figure 4

Shell small, subpupiform, everywhere marked by minute, growth lines and equally fine, incised, spiral lines, shining, white throughout, except the tip of the columella and a narrow, reddish-brown, spiral band extending from the first remaining postnuclear whorl to the edge of the outer lip and covering the sutures and upper row of tubercles; nuclear whorls decollated; remaining postnuclear whorls, 4½, moderately rounded, marked throughout by three subequal and subequally spaced, indistinctly defined, spiral cords, the posterior near the suture, the anterior separated from the suture by a space about equal to that dividing the anterior and median cords; spiral cords crossed by rather stronger, slightly retractive, axial ribs, about 16 appearing on the first whorl and 18 on the penultimate, the intersections marked by large, bead-like tubercles, somewhat broken up by the growth lines, and fine incised, spiral lines; spaces enclosed by the axial ribs and spiral cords irregular, but generally roundly oval, elongated spirally and becoming more quadrangular on the last whorl; periphery marked by a narrow, irregularly tuberculate cord; sutures moderately impressed and rendered indistinct by the crossing of the axial ribs; base rather long, slightly concave on the buccal side, evenly rounded behind, marked by two slender, diverging, tuberculate cords; aperture subpyriform, the anterior canal broad and open; outer and basal lips thin, crenulated by the external sculpture; columella revolute, covered by a callus extending over the parietal wall. Length, 1.17 mm.; diameter, .89 mm.

*Holotype:* No. 5457, C. A. S. Paleo. Type Coll., and three additional specimens, from Cape San Lucas, Lower California, collected by G. D. Hanna and E. K. Jordan, June, 1925.

The species closely resembles *Cerithiopsis cassi* of this paper from the same locality, especially in color pattern and general shape, but it differs very radically in the large, irregular tubercles, the rather broad, axial ribs and non-laminate spiral cords, and the smaller, ill-defined, rounded or oval interspaces, which are large, squarish and well defined in *C. cassi.* The peculiar cutting up of the tubercles by the growth lines and spiral incised lines is very characteristic, a condition shown in less degree in *C. grippi.*

The species is named for Miss Viola Bristol of Point Loma, California.

### 7. **Cerithiopsis (Cerithiopsida) cassi** Baker, Hanna and Strong, new species

Plate 19, figure 5

Shell minute, subpupiform, everywhere marked by almost imperceptible, incised spiral lines, blue-white, except a narrow, reddish-brown, spiral band covering the posterior row of tubercles, beginning on the first postnuclear whorl and continuing along the posterior cord and peripheral cord to the edge of the aperture; nuclear whorls two, the first smooth, mammillate, the second separated from it by an impressed suture, convex, showing the beginning of the sculpture of the succeeding postnuclear whorl; postnuclear whorls, 4½, slightly convex, marked by three rows of minute, glistening, evenly rounded tubercles, nearly equal on the first two whorls, the posterior row becoming more prominent on the succeeding turns; tubercles united by very narrow, rather prominent, laminate, strongly retractive, axial ribs, and three almost equally prominent, laminate, spiral cords enclosing large and rather deep, squarish pits, much wider than the tubercles; tubercles numbering about 15 on the first whorl, 16 on the third and 18 on the last; spiral cords nearly equally spaced, the middle being slightly nearer the posterior than the anterior, the anterior separated from the suture by a space equal to that between it and the middle cord, this space being occupied by a series of squarish pits equal to the other intercostal spaces; axial ribs crossing the sutures prominently, rendering the impressed sutures rather indistinct; peripheral cord nearly equal to the preceding one, its tubercles showing a slight tendency to become elongated spirally, extending into all the sutures as a very narrow, wavy cord, separated from the posterior row of tubercles by a minute, incised groove; base moderate, nearly straight, or showing a slight concavity in the umbilical region, marked by obsolescent sculpture similar to that on the body whorl; aperture irregularly ovate with a short, broad, anterior canal; columella nearly straight and vertical, heavily calloused, obliquely truncate anteriorly. Length, 1.99 mm.; diameter, 1.03 mm.

*Holotype:* No. 5458, C. A. S. Paleo. Type Coll., and two additional specimens, from **Cape San Lucas, Lower California;** collected by G. D. Hanna and E. K. Jordan, June, 1925; one specimen from Espiritu Santo Island, Gulf of California, is in the Baker collection.

In size and shape this species resembles *Cerithiopsis pupiformis* Carpenter, but differs in the color band, the small size of the tubercles, the rather extreme width of the squarish, intercostal pits and in having a peripheral cord instead of a sulcus. It seems distinct from all species described from this coast, except *C. bristolæ* of this paper, under which species the characteristic differences have been noted.

The species is named for Mr. Charles L. Cass of Pacific Beach, California.

### 8. **Cerithiopsis (Cerithiopsida) kinoi** Baker, Hanna and Strong, new species

Plate 18, figure 6

Shell small, slender, regularly elongate-conic, light chestnut brown; remaining nuclear whorls, 2½, somewhat eroded, well rounded and separated by impressed sutures, colored like the rest of the shell, the last showing the tendency of the subgenus to develop sculpture similar to that of the postnuclear whorls; postnuclear whorls, 7½, very moderately convex, marked by three narrow, prominent, nearly equally spaced, spiral cords, the first close to the upper suture, the third quite widely separated from the lower suture by a space about equalling that separating the spiral cords; the middle cord rather more prominent than the other two, all crossed by retractive axial ribs, nearly equal in size, and similar to the spiral cords, about 18 appearing on the first whorl, 20 on the fifth and 26 on the penultimate; intersections of the cords and ribs marked by small, rounded, beady tubercles tending to be spirally elongate at several points, the interspaces being generally marked by well-defined, deep, roundish pits tending to become squarish at some points on the lower whorls; interspaces between the lowest cord on each whorl and the suture marked by an almost identical series of roundish pits dipping into the suture and squarely defined below by a very narrow, sharp extension of the peripheral cord, appearing more or less distinctly in all the sutures, closely adnate to the succeeding whorls, and giving the appearance of a very narrow shoulder; sutures rather deeply impressed but largely obliterated by the extensions of the axial ribs; peripheral cord about equal to the preceding spiral cord but less tuberculate, the space above it about equal to that separating the other spiral cords; base rather short, well-rounded, marked by feeble extensions of the axial ribs, by one scarcely tuberculate cord beginning near the peripheral cord and gradually separating from it, and by an ill-defined columellar fasciole; aperture broadly, irregularly oval;

outer lip thin and crenulated by the external sculpture; basal lip horizontal and only slightly convex; anterior canal short, rather broad and oblique; columella nearly vertical, obliquely truncate below. Length, 3.25 mm.; diameter, .99 mm.

*Holotype:* No. 5451, C. A. S. Paleo. Type Coll., and five additional specimens from **Cape San Lucas, Lower California;** collected by G. D. Hanna and E. K. Jordan, June, 1925; one specimen from about four fathoms off La Paz, Lower California.

The species shows a very marked tendency of the upper row of tubercles to be carried to the left of a line connecting the corresponding lower two tubercles, thus bending the axial ribs retractively on each whorl. The same tendency shows on all the specimens seen, but in a varying degree. The species seems to be distinct from any heretofore described from this coast, being more closely allied to *Cerithiopsis bristolæ* and *C. cassi* of this paper, but differing from both in color, in the number of axial ribs, and in being more slenderly elongate-conic. It is intermediate between them in having the small tubercles and large intercostal pits of *C. cassi*, but differs from that species and resembles *C. bristolæ* in that the pits are roundish and not squarish.

The species is named for Fra Eusebio Francisco Kino, Jesuit pathfinder employed by the vice-regency of New Spain to survey the Gulf of California, in 1685. While engaged in this work he collected shells in that region. The species is named in accordance with the suggestion of Joshua L. Baily, Jr. (Nautilus, vol. 48, No. 3, January, 1935, p. 75).

### 9. **Cerithiopsis (Cerithiopsida) kinoi** (subspecies?)

Plate 19, figure 6

A single specimen from Cape San Lucas, Lower California, is like *C. kinoi* of this paper, but varies in having the tubercles almost imperceptible, the intercostal pits rather larger and distinctly squarish, while the shell is broader in proportion to its height. We refrain from giving this shell a subspecific name, preferring to await further collecting to determine its validity.

### 10. **Cerithiopsis (Cerithiopsida) porteri** Baker, Hanna and Strong, new species

Plate 19, figure 2

Shell very small, spindle-shaped, everywhere marked by minute growth lines and spiral incised lines, chestnut brown except the nucleus; nuclear whorls, 4½, cream white, forming a high, narrow nucleus with a mammillated tip, the whorls well rounded and separated by moderately impressed sutures, the first turn and a half smooth, the rest showing both spiral and axial sculpture resembling that of the succeeding turns; postnuclear whorls, 6½, very slightly convex, rather low between the sutures, marked by two very prominent, widely separated, heavily tuberculate, spiral cords with a third, minute, irregularly tuberculate, median cord showing very indefinitely on the last two whorls; spiral cords crossed by decidedly retractive axial ribs, generally not well defined, 16 appearing on the second whorl, 18 on the fourth and 20 on the penultimate turn; spiral cords about equal on the early whorls, the tubercles of the posterior cord elongated axially on the lower turns, rendering this cord by far the most prominent; tubercles of the anterior cord truncated rather sharply posteriorly on the last whorl; periphery marked by a moderate sulcus continuous with the last turn of the suture; base well rounded, marked by three very strong, basal cords, the first with large tubercles, the second rugose but not tuberculate, the third constituting a basal fasciole; sutures rather deep but rendered indistinct by the large tubercles and axial ribs; aperture subcircular, less rounded on the columellar side; outer lip showing the external sculpture, and marked on the edge by minute tubercles; anterior canal short and narrow; columella and parietal wall heavily calloused, the columellar callus reflected, free and minutely beaded on the edge. Length, 2.17 mm.; diameter, .596 mm.

*Holotype:* No. 5455, C. A. S. Paleo. Type Coll., and five additional specimens collected in the **"Gulf of California"** by George D. Porter.

By virtue of its small size and spindle shape this species falls into the group of *Cerithiopsis pupiformis* Carpenter and *C. cassi* of this paper, but differs from these and all other species described from this coast in having but two spiral cords, the minute, median cord noted, scarcely amounting to a spiral cord. Only the holotype retains the full nucleus. Among the other specimens there is considerable variation in the size of the tubercles and in the incidence of the minute mesial cord.

### 11. **Cerithiopsis (Cerithiopsidella) cosmia** Bartsch

*Cerithiopsis cosmia* BARTSCH, Proc. U. S. Nat. Mus., vol. 33, Oct. 23, 1907, pp. 180, 181.

*Cerithiopsis* (*Cerithiopsidella*) *cosmia* BARTSCH, Proc. U. S. Nat. Mus., vol. 40, 1911, pp. 348, 349, pl. 38, fig. 7.

A single specimen of this species in the Baker collection is labeled "Gulf of California," but as there is a possibility of error, this large addition to the known range of the species should not be accepted without further collections. Dall (Bull. 112, U. S. N. M., 1921, p. 143) gives the range Monterey, California, to San Bartolome Bay, Lower California.

### 12. **Seila assimilata** (C. B. Adams)

Plate 18, figure 5

*Cerithium assimilatum* C. B. ADAMS, Cat. Panama Shells, Ann. Lyc. Nat. Hist., New York, vol. 5, 1852, pp. 374–375, 533 (separate pp. 150–151).

This species was taken at Coyote Bay, Concepcion Bay, Puerto Escondido, La Paz, and Cape San Lucas, Lower California; at Amortajada Bay, the salt works and the west anchorage, San Jose Island, and at Isthmus Bay, Espiritu Santo Island, Gulf of California.

We are unable to detect any difference between this species and *S. montereyensis* Bartsch, except that the specimens are much smaller, a feature noted by Bartsch. Bartsch's description does not seem to separate them positively in any other respect.

### 13. **Metaxia diadema** Bartsch

Plate 18, figure 8

*Metaxia diadema* Bartsch, Proc. U. S. Nat. Mus., vol. 33, Oct. 23, 1907, pp. 182, 183.

Taken in San Francisquito Bay, Lower California, in about three fathoms.

### 14. **Metaxia convexa** (Carpenter)

Plate 18, figure 4

*Cerithiopsis convexa Carpenter*, Cat. Mazatlan Shells, 1857, p. 444.

A single specimen was collected by George D. Porter in the "Gulf of California" and additional ones at Maria Madre Island by the Expedition of 1925.

## Family CERITHIIDÆ

*Key to west American genera and subgenera of the family Cerithiidæ*

Columella with an oblique median plication .......... *Clava*
Columella without a plication
 * Anterior canal distinct, nearly closed, strongly recurved .......... *Cerithium*
 * Anterior canal short, open, straight or nearly so .......... *Potamides*
 ** Shell turriculated, with irregular ribs and varices .......... *Pirenella*[2]
 ** Shell subcylindrical, spirally grooved .......... *Liocerithium*[2]
 * Anterior canal a narrow groove, outer lip thickened .......... *Cerithidea*
 * Anterior canal undeveloped
 ** Aperture effuse at the junction of the outer and basal lips .......... *Diastoma*
 ** Aperture oval, more or less channeled anteriorly .......... *Bittium*[3]
 *** Postnuclear whorls with varices .......... *Bittium s. s.*[2]
 *** Postnuclear whorls without varices
 **** Nuclear whorls with two spiral lirations .......... *Lirobittium*[2]
 **** Nuclear whorls smooth
 ***** Spiral sculpture predominating over the axial .......... *Stylidium*[2]
 ***** Spiral sculpture not predominating over the axial .......... *Semibittium*[2]
 ** Aperture effuse at the columellar base, a minute umbilical chink behind the columella .......... *Alabina*

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[2] Subgenera.
[3] Key to the subgenera of *Bittium*, adapted from Bartsch, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 384.

### 15. **Alabina diomedeæ** Bartsch

*Alabina diomedeæ* BARTSCH, Proc. U. S. Nat. Mus., vol. 39, 1911, p. 413, pl. 62, fig. 1.

Two worn specimens of this species were obtained at Cape San Lucas, Lower California, and in the Baker collection there is a large number, collected in beach drift by George D. Porter on Espiritu Santo Island, Gulf of California. Also several hundred were collected along the surf line of the outer coast at Magdalena Bay by G. D. Hanna in 1922.

### 16. **Bittium mexicanum** Bartsch

*Bittium mexicanum* BARTSCH, Proc. U. S. Nat. Mus., vol. 40, 1911, pp. 412, 413, pl. 58, fig. 1.

Two specimens were taken by George D. Porter in the "Gulf of California."

### 17. **Cerithium alboliratum** Carpenter

Plate 17, figure 7

*Cerithium alboliratum* CARPENTER, Cat. Mazatlan Shells, 1857, p. 356.

The species was taken at Cape San Lucas, Lower California, and it is in the Baker collection from Espiritu Santo Island, in the Gulf.

### 18. **Cerithium maculosum** Kiener

Plate 17, figure 2

*Cerithium maculosum* KIENER, Icon. Coq. Viv., *Canaliferes*, pt. 1, 1841–1842, p. 36, pl. 13, fig. 3.

*Cerithium nebulosum* SOWERBY, Thes. Conch., vol. 2, 1855, *Cerithium*, p. 866, sp. 71, pl. 179, fig. 48; not PHILIPPI, 1851.

The species was taken at the salt works, Carmen Island; Coronado Island; the salt works and Amortajada Bay, San Jose Island; Isla Raza; San Francisco Island; San Marcos Island; Isthmus Bay, Espiritu Santo Island; Ceralbo Island; and Santa Catalina Islands, Gulf of California; at Cape San Lucas and La Paz, Lower California; and at Tepoca Bay and San Carlos Bay, Sonora.

### 19. **Cerithium stercus-muscarum** Valenciennes

Plate 17, figure 3

*Cerithium stercusmuscarum* VALENCIENNES, Voy., Humboldt & Bonpland, 1833 (1832), *Zool.*, vol. 2, p. 278.

*Cerithium irroratum* GOULD, C. B. ADAMS, Cat. Panama Shells, Ann. Lyc. Nat. Hist., New York, vol. 5, 1852, p. 378 (separate p. 154); not GOULD.

*Cerithium ocellatum* Bruguiere may be the same species, in which case this name would supersede that of Valenciennes. There is a lack of agreement as to their identity.

The species was taken in large numbers in the broken drain pipes on the beach, south of the main wharf, at La Paz; at Coyote Bay; Concepcion Bay; Angeles Bay; Agua Verde Bay; Las Animas Bay; San Luis Gonzaga Bay; and Mulege Harbor, Lower California; at Guaymas, Sonora; and on Isla Raza; San Luis Island; Marquer Bay, Carmen Island; west anchorage, San Jose Island; Angel de la Guardia Island; and Monserrate Island, Gulf of California.

### 20. **Cerithium uncinatum** (Gmelin)

Plate 17, figure 1

*Murex uncinatus* GMELIN, Syst. Nat. Ed. 13, vol. 1, pt. 6, 1790, p. 3542, no. 57.

*Cerithium famelicum* C. B. ADAMS, Cat. Panama Shells, Ann. Lyc. Nat. Hist., New York, vol. 5, 1852, pp. 376, 533 (separate p. 152).

The species was taken at Ballandra Bay, Carmen Island; west landing, San Jose Island; and San Marcos Island, Gulf of California.

### 21. **Clava gemmata** (Hinds)

Plate 17, figure 5

*Vertagus gemmatus* HINDS, Voy. *Sulphur*, Moll., 1844, p. 27, pl. 11, fig. 5, 6.

*Clavæ californica* DALL, Proc. U. S. Nat. Mus., vol. 56, Aug. 30, 1919, p. 346.

Specimens were taken at the west anchorage, Amortajada Bay and the salt works, San Jose Island, Gulf of California; and at Cape San Lucas, Lower California.

Carpenter (Rep. Brit. Assoc., 1856, p. 170) suggested that *Cerithium fragaria* Valenciennes may be the young of this species. If this should prove correct, the latter name would take precedence.

## 22. **Potamides (Liocerithium) sculptus** (Sowerby)

Plate 17, figure 6

*Lampania sculpta* Sowerby, Thes. Conch., vol. 2, 1855, p. 868, fig. 144, 145.
*Lampania incisa* Sowerby, Thes. Conch., vol. 2, 1855, p. 868, fig. 152.
*Lampania curta* Sowerby, Thes. Conch., vol. 2, 1855, p. 869, fig. 153, 154.

The species was taken at Coronado Island; Isla Raza; San Marcos Island; Georges Island; salt works and Marquer Bay, Carmen Island; west anchorage, San Jose Island; northeast anchorage, Monserrate Island; second anchorage, Tiburon Island; Isthmus Cove, Espiritu Santo Island; first anchorage, Santa Catalina Island; Smith Island; Isla Partida; San Luis Island; San Francisco Island; San Esteban Island; San Diego Island; Sal si puedes Island; Pond Island Bay and Puerto Refugio, Angel de la Guardia Island; and Danzante Island, Gulf of California; at San Luis Gonzaga Bay; San Francisquito Bay; Agua Verde Bay; Angeles Bay; Las Animas Bay; San Antonio Point and La Paz, Lower California; and at Tepoca Bay; San Carlos Bay; and Guaymas, Sonora.

## 23. **Cerithidea albonodosa** Carpenter

Plate 17, figure 4

*Cerithidea albonodosa* Carpenter, Proc. Zool. Soc. London, July 8, 1856, p. 205.

Taken at northeast anchorage, Monserrate Island; San Luis Island, and at nearly every sand beach visited in the Gulf of California.

## 24. **Cerithidea albonodosa mazatlanica** Carpenter

*Cerithidea varicosa* Sowerby, var. *mazatlanica* Carpenter, Cat. Mazatlan Shells, 1857, pp. 344, 345.

Taken at Pond Island, Gulf of California.

*Cerithidea dæmonia Dall*, (manuscript name) from the Gulf of California, which has been widely distributed to collectors, proves to be a very dark color form of this subspecies.

## 25. **Cerithidea montagnei** (d'Orbigny)

Plate 18, figures 1, 2

*Cerithium montagnei* d'Orbigny, Voy. Amér. Mérid., vol. 5, 1841, p. 443, pl. 63, figs. 3, 4.
*Cerithium reevianum* C. B. Adams, Cat. Panama Shells, Ann. Lyc. Nat. Hist., New York, vol. 5, 1852, pp. 380, 534 (separate p. 156).

Many excellent specimens of this beautiful species were taken at San Ignacio Lagoon, Lower California, by Henry Hemphill. These agree in all essential details with d'Orbigny's original figure. Seven excellent specimens were taken by L. G. Hertlein at Tenecatita Bay, Jalisco, Mexico.

### 26. **Cerithidea fortiuscula** (Bayle)

Plate 18, figure 3

*Cerithium fortiusculum* BAYLE, Journ. Conchyl., vol. 28 (ser. 3, vol. 20, no. 3), 1880, p. 250.—TYRON, Man. Conch. vol. 9, 1887, p. 161, pl. 33, fig. 58.

One immature shell was taken at the northeast anchorage, Monserrate Island, Gulf of California, and an adult was found at Las Animas Bay on the peninsula. The species seems to have no very close relationship with *montagnei*, with which it has been associated by some writers.

## Family CYCLOSTREMATIDÆ

In the present paper the arrangement of genera and species used by Dall in Bulletin 112, U. S. National Museum, for the California shells has been expanded to include the species occurring below San Diego. Two changes have been made, the first in the use of the family name of *Cyclostrematidæ* instead of *Vitrinellidæ*. The genus *Cyclostrema*[4] is credited to Marryatt in 1818 and the genus *Vitrinella*[5] to C. B. Adams in 1850. We have followed the rule for forming the family name from the first described genus. The second change is in the use of the genus *Delphinoidea* Brown, 1827,[6] instead of *Cyclostremella* Bush, 1897.[7] The former name seems to be valid, and the type of the genus is more like our shells than is the case with that of the later genus.

C. B. Adams described a number of species in the family from Panama, and Carpenter several from Mazatlan, few of which can be retained in the genera in which they were described. The shell characters which we have used in arranging the west coast species in the various genera are shown in the following key. Nearly all of the species described by Adams and Carpenter are unfigured and the types are not available for comparison. In order to attempt an identification of our shells it was necessary to compare their descriptions with the descriptions and figures of Dall and Bartsch. The result of this study is shown in the keys to the species which we have placed in the various genera. These include everything from the west coast for which we found a record. Since the keys are based

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[4] Trans. Linn. Soc., London, vol. 12, 1818, p. 338.

[5] Mono. *Vitrinella*, 1850, p. 3.

[6] Illust. Conch. Gr. Brit. Ireland, 1827, p. 4.

[7] Trans. Conn. Acad. Arts and Sci. vol. 10, pt. 1, 1897, p. 140. Monotype, *C. humulis* Bush, op. cit., p. 141, pl. 22, figs. 8–8b.

very largely on the written descriptions, and not on the shells themselves, they must be considered as provisional.

A number of small series or single specimens in the Academy's collection do not seem to agree with any of the forms described from the Gulf of California but some of them are more or less similar to forms described from distant localities. Rather than extend ranges from the meager data available, it seemed better to describe them as new. If larger series of specimens and specimens from intermediate points show the differences to be individual variations, the figures and full descriptions should still be of value.

*Key to west American genera of the family Cyclostrematidæ*

Base with a callus pad restricting or covering the umbilicus......... *Teinostoma*
Base openly umbilicated, without a callus
* Shell naticoid, spire elevated.................................. *Ganesa*
* Shell flattened, spire low or sunken
** Outer lip sinuated or waved............................ *Scissilabra*
** Outer lip not sinuated or waved
*** Spiral sculpture absent.................................. *Vitrinella*
*** Spiral sculpture present
**** Whorls rounded, with many equal spiral cords of incised lines.. *Delphinoidea*
**** Whorls angulated, with a few sharp spiral keels
***** Axial sculpture present.................................. *Cyclostrema*
***** Axial sculpture absent.................................. *Circulus*

*Key to west American species of the genus Ganesa*

Umbilicus bounded by a conspicuous keel; diam., 1.2 mm.
Mazatlan.................................. *naticoides* Carpenter
Umbilicus bordered by from 12 to 15 spiral striae; diam., 4.5 mm.
Panama.................................. *panamensis* Dall
Umbilicus not emarginated
* Entire surface with subgranular vermiculations; diam., 2 mm.
Galapagos Islands.................................. *piona* Dall
* Entire surface with thread like axial folds; diam., 2.5 mm.
Galapagos Islands.................................. *filosa* Dall

*Key to west American species of the genus Teinostoma*

Umbilicus entirely covered by a smooth callus pad
* Body whorl with a furrow and keel near the suture; diam., 2 mm.
Monterey to Gulf of Calif.......................... *supravallata* Carpenter
* Body whorl acutely carinated below the periphery; diam., 1 mm.
Mazatlan.................................. *carinata* Carpenter
* Body whorl angulated at the center of the base; diam., 2 mm.
Monterey to the Gulf of Calif.................. *invallata* Carpenter
* Body whorl evenly rounded
** Surface with finely decussated sculpture; diam., 1.2 mm. Mazatlan.................................. *pyricallosa* Carpenter
** Surface with subrugose spiral striae; diam., 1.1 mm. Mazatlan
.................................. *pallidula* Carpenter

** Surface with subobsolete spiral striae; diam., 1 mm. Mazatlan ..... *tumens* Carpenter
** Surface without sculpture;
*** Callus pad spiral, flattened toward the inner lip; diam., 2.75 mm. Mazatlan ..... *amplectans* Carpenter
*** Callus pad rounded, smooth; diam., 3.5 mm. Magdalena Bay .. *cecinella* Dall

Callus pad showing an umbilical indentation or dimple
* Umbilicus deeply indented; diam., 1.8 mm. Panama ..... *regularis* Adams
* Umbilical dimple minute; diam., 1.8 mm. Coronados Islands .. *salvania* Dall

Callus pad leaving a slight umbilical chink
* Surface with fine spiral striations; diam., 1 mm. Mazatlan. *lirulata* Carpenter
* Surface without sculpture
** With a large, ovate pad behind the pillar lip; diam., 2 mm. San Pedro ..... *sapiella* Dall
** With a small, linguiform pad only; diam., 2 mm. San Diego ... *bibbiana* Dall
** With a semi-lunular pad; diam., 1 mm. Mazatlan ..... *amplectans* Carpenter

Callus pad curving around an open umbilicus
* Body whorl subangulated at the periphery; diam., 1 mm. Panama ..... *minuta* Adams
* Body whorl evenly rounded; diam., 1 mm. Mazatlan .. *substriata* Carpenter

### *Key to west American species of the genus Scissilabra*

Axial sculpture present
* Body whorls with 4 spiral keels; diam., 1.25 mm. Mazatlan to Panama ..... *parva* Adams
* Body whorl with 5 spiral keels; diam., 1.6 mm. Mazatlan to Panama ..... *panamensis* Adams
* Body whorl with finely decussated sculpture
** Shell subelevated; diam., 1.4 mm. Mazatlan ..... *monile* Carpenter
** Shell discoidal; diam., 1 mm. Mazatlan ..... *monilifera* Carpenter

Axial sculpture absent
* Body whorl sharply angulated at periphery; diam., 2 mm. Monterey to Gulf of Calif ..... *dalli* Bartsch
* Body whorl subangulated below the periphery; diam., 1 mm. Mazatlan ..... *subquadrata* Carpenter

Body whorl evenly rounded
** Body whorl with uniform spiral striae; diam., 1.4 mm. Mazatlan ..... *bifilata* Carpenter
** Spiral striae at periphery only; diam. 0.8 mm. Mazatlan ... *orbis* Carpenter

### *Key to west American species of the genus Vitrinella*

Umbilical walls smooth (*Vitrinella* s. s.)
* Surface with distinct, irregular impressed lines; diam., 2.1 mm. Cayucos to Pt. Abreojos ..... *oldroydi* Bartsch
* Surface with distinct, regular lines of growth; diam., 1.2 mm. San Pedro ..... *smithi* Bartsch
* Surface smooth and glossy
** Shell subglobose, spire somewhat elevated; diam., 1.6 mm. Unalaska ..... *alaskensis* Bartsch
** Shell flattened, spire little elevated; diam., 2.3 mm. San Pedro ..... *eschnauri* Bartsch
** Shell discoidal, spire depressed; diam., 5.5 mm. San Pedro ..... *williamsoni* Dall

Umbilical walls with oblique ribs or notches (*Decomphala*)
* Base with a single spiral keel; diam., 2.2 mm. Monterey to San Diego.............................................*berryi* Bartsch
* Base without keels
** Upper whorls axially ribbed; diam., 3.8 mm. Monterey to Reef Pt.............................................*stearnsi* Bartsch
** Upper whorls marked by lines of growth only; diam., 1.5 mm. Departure Bay, B. C............................*columbiana* Bartsch

*Key to west American species of the genus Delphinoidea*

Surface with raised spiral threads
* Whorls slightly constricted at regular intervals; diam., 2.3 mm. Monterey to San Diego..........................*californica* Bartsch
* Whorls with a ripple marked aspect; diam., 1.3 mm. Gulf of Calif. ..............................................*dalli* Bartsch
* Interstices between threads axially striated
** Shell minute; diam., 2 mm. Panama..............*ponceliana* de Folin
** Shell large for the genus; diam., 5 mm. Cape San Lucas..*granti* B. H. and S.
* Spiral threads regularly and finely beaded; diam., 2 mm. Olga, Wash.........................................*concordia* Bartsch
* Sculpture on last whorl finely decussated; diam., 1 mm. Mazatlan ..........................................*decussata* Carpenter
* Spiral threads and interspaces smooth
** A smooth band between suture and first spiral; diam., 1.5 mm. Cape San Lucas..........................*lucasana* B. H. and S.
** Spiral threads subequally spaced
*** Shell moderately elevated
**** Spiral threads on last whorl about 15; diam., 1.2 mm. Gulf of Calif....................................*spiritualis* B. H. and S.
**** Spiral threads on last whorl about 50; diam., 1.6 mm. Tres Marias Islands.............................*stephensæ* B. H. and S.
*** Shell depressed turbinate; diam., 2 mm. San Diego......*rossellina* Dall
*** Shell discoidal; diam., 2.1 mm. Mazatlan............*lirulata* Carpenter
Surface with incised spiral lines
* Incised lines on both spire and base; diam., 0.85 mm. Cook Inlet, Alaska.....................................*alaskana* Bartsch
* Incised lines strong on base only; diam., 1.5 mm. Panama..*seminuda* Adams

*Key to west American species of the genus Cyclostrema*

Space between keels spirally sculptured
* Three spiral keels on body whorl
** Two of keels on periphery, one on base; diam., 4.5 mm. San Pedro to Gulf of Calif.........................*baldridgei* Bartsch
** All keels on the periphery; diam., 3.97 mm. Gulf of Calif..*spiceri* B. H. and S.
* Four spiral keels on the body whorl; diam., 1.5 mm. Mazatlan to Panama.........................................*exigua* Adams
* Five spiral keels on the body whorl; diam., 2.28 mm. Tres Marias Islands................................*mariæ* B. H. and S.
Space between keels not spirally sculptured
* Three spiral keels on the body whorl
** Upper keel nodulous; diam., 0.8 mm. Mazatlan.......*nodosa* Carpenter
** All keels smooth
*** A strong spiral keel on the periphery; diam., 1 mm. San Diego ...........................................*diegensis* Bartsch

*** A spiral keel on each side of the periphery; diam., 0.9 mm. Panama . . . . . . *perparva* Adams
* Four spiral keels on the body whorl
** Upper keel nodulous; diam., 1.4 mm. Mazatlan . . . . . . *coronata* Carpenter
** All keels smooth; diam., 1 mm. Panama . . . . . . *janus* Adams
* Five spiral keels on body whorl
** Two keels on periphery, three on base; diam., 1.4 mm. Cape San Lucas . . . . . . *xantusi* Bartsch
** Three keels on periphery, two on base
*** Axial riblets reaching the umbilicus; diam., 2.1 mm. San Pedro . . . . . . *miranda* Bartsch
*** Axial riblets becoming obsolete on base; diam., 1.5 mm. Panama . . . . . . *concinna* Adams
* Six spiral keels on the body whorl
** Axial nearly equalling the spiral keels in strength; diam., 1.3 mm. Panama . . . . . . *adamsi* Bartsch
** Axial riblets strong on base and in umbilicus only; diam., 2.42 mm. Gulf of Calif . . . . . . *lowei* B. H. and S.

*Key to west American species of the genus Circulus*

A single spiral keel on the periphery; diam., 2.2 mm. Panama . . *diomedæ* Bartsch

One spiral keel on periphery, one on the spire; diam., 1 mm. Mazatlan . . . . . . *planospiratus* Carpenter

One spiral keel below suture, one on base; diam., 1.5 mm. Panama . . . . . . *modestus* Adams

One spiral keel on periphery, two on base; diam., 1.2 mm. Mazatlan . . . . . . *annulatus* Carpenter

One spiral keel on periphery, one on spire, one on base
* Umbilicus bordered with callus wash; diam., 2.69 mm. Tres Marias Islands . . . . . . *madreënsis* B. H. and S.
* Umbilicus region not calloused; diam., 2.5 mm. Panama . . *valvatoides* Adams

Two spiral keels on periphery, two on base; diam., 0.85 mm. Mazatlan . . . . . . *cinctus* Carpenter

Three spiral keels on periphery only
* Upper keel visible on spire; diam., 1.8 mm. Panama . . . *tricarinatus* Adams
* Upper keel not visible on spire; diam., 1.6 mm. La Paz . . . *liriope* Bartsch

Four equally spaced keels on body whorl
* Interspaces with fine spiral striae; diam., 2.5 mm. Cedros Island . . . . . . *cerrosensis* Bartsch
* Interspaces smooth; diam., 2.5 mm. Catalina Island . . . . . *cosmius* Bartsch

Five spiral keels on the body whorl; diam., 0.75 mm. Mazatlan . . . . . . *carinulatus* Carpenter

Six spiral keels on the body whorl; diam., 1.3 mm. Mazatlan . . . . . . *bifrontius* Carpenter

### 27. **Cyclostrema diegensis** Bartsch

*Cyclostrema diegensis* Bartsch, Proc. U. S. Nat. Mus., vol. 32, 1907, p. 172, text figs. 7, *a*, *b*, *c*.—Oldroyd, Stanford Univ. Publ. Univ. Ser. Geol. Sci., vol. 2, pt. 3, 1927, p. 220, pl. 107, fig. 7, 8, 9.

A single immature specimen, taken in about three fathoms at the northeast anchorage, Monserrate Island, Gulf of California, seems to fall here. However, this large extension of range should not be accepted without further confirmatory collecting. Dall (Bull. 112, U. S. N. M., 1921, p. 182) gives the range as San Diego, California.

### 28. **Cyclostrema exigua** (C. B. Adams)

Plate 21, figures 10, 11, 12

*Vitrinella exigua* C. B. Adams, Cat. Panama Shells. Ann. Lyc. Nat. Hist. New York, vol. 5, 1852, pp. 408–409, 539 (separate pp. 184, 185).—Carpenter, Cat. Mazatlan Shells, 1857, pp. 243, 244.

Six specimens from Cape San Lucas, Lower California, agree well with Adams' and Carpenter's descriptions.

### 29. **Cyclostrema lowei** Baker, Hanna and Strong, new species

Plate 20, figures 1, 2, 3

Shell rather small, depressed above, white; nuclear whorls about 1½, smooth, mammillate, very slightly convex, but with distinct sutures; postnuclear whorls a little more than one, increasing very rapidly both laterally and vertically, especially in the last quarter turn, with spiral sculpture very indistinct at first, but showing toward the aperture five strong spiral keels, one carinating the periphery, three above this and quite close, and a fifth more distinct and equally close to the slightly impressed suture, the last marked by low tubercles, elongated spirally, from which indistinct, axial ribs extend retractively across the intercostal space and over the next succeeding keel, producing minute tubercles at the intersections; base marked by a low, indistinctly tuberculate, spiral keel, about half way between the periphery and the edge of the umbilicus, from which a series of axial ribs extend into the umbilicus, enlarging as they dip over the sharply rounded edge of the whorl, producing from 20 to 30 distinct teeth; umbilicus contained about 4½ times in the greatest diameter, perspective showing the rather sharp edges of the whorls within; aperture not very oblique, nearly circular, with an entire peristome expanding in the columellar region. Greatest diameter, 2.42 mm.; least diameter, 1.71 mm.; altitude, 1.48 mm.

*Holotype:* No. 5461, C. A. S. Paleo. Type Coll., with one additional mature and five immature specimens from **Cape San Lucas, Lower California;** collected by G. D. Hanna and E. K. Jordan, June, 1925. Four much worn shells were taken at Espiritu Santo Island, Gulf of California, in 1921.

The species is possibly nearest to *C. miranda* Bartsch,[8] in the basal keel, and the form of the perspective umbilicus showing the preced-

[8] Proc. U. S. Nat. Mus., vol. 39, 1911, p. 230, pl. 39, figs. 1–3.

ing whorls within, but differs markedly in the distribution of the upper keels, and in the distinct teeth within the umbilicus. All of the specimens are beach worn, and it is probable that living shells would show the sculpture to be very much stronger, with a possibility that the axial ribs extend over the whole shell. One immature specimen shows such axial sculpture more marked than growth lines on all the intercostal spaces. It is also probable that the type is not quite mature, but the rapid enlargement of the last whorl in the last quarter turn indicates near maturity.

The species is named for the late Mr. Herbert N. Lowe.

### 30. **Cyclostrema mariæ** Baker, Hanna and Strong, new species

Plate 21, figures 7, 8, 9

Shell of medium size among the west coast species of the genus, rather depressed, white; nuclear whorls 1¾, depressed, shining, with indistinct sutures, marked by a central, spiral keel with a concave band on each side; postnuclear whorls 2½, the first showing a rather abrupt change of sculpture from that of the nuclear whorls, consisting at first of two slightly diverging keels near the upper suture, with a rather broad, concave space below, the whole whorl marked by very numerous, narrow, arcuate, retractive axial ribs, rather evenly spaced, with narrower interspaces, rendering the keels tuberculate at their intersections; lower portion of the whorl early becoming filled with about five low, tuberculate, spiral cords; main spiral keels on the last whorl five, two near the upper suture, one near the periphery, one at the periphery, carinating it, and marked by about 36 large, low, irregular tubercles, and one bordering the umbilicus, the intervening spaces being filled by smaller, tuberculate, spiral cords, irregularly sized and spaced, the whole surface being also marked by very numerous, slightly arcuate, retractive, axial ribs, more than a hundred appearing on the last whorl; sutures very indistinct, crossed more or less continuously by the axial ribs; umbilicus perspective, funnel-shaped below, showing the whorls within nearly, or quite to the apex, everywhere marked by spiral cords and axial ribs similar to the external sculpture; aperture fractured but evidently subcircular; peritreme continuous, slightly thickened within. Greatest diameter, 2.28 mm.; least diameter, 1.61 mm.; altitude, 1.24 mm.

*Holotype:* No. 5465, C. A. S. Paleo. Type Coll., from **Maria Madre Island, Tres Marias group** off the west coast of Mexico, collected by G. D. Hanna and E. K. Jordan, June, 1925.

The unique holotype is so distinct from all species described from this coast that its description seems warranted.

### 31. **Cyclostrema spiceri** Baker, Hanna and Strong, new species

Plate 20, figures 4, 5, 6

Shell large among the species described from this coast with a slightly elevated spire, shining, translucent, white; nuclear whorls about 1½, marked throughout by a narrow, rounded, nearly smooth and shining spiral keel, the remaining portions of the whorls dull white, and dipping concavely to the sutures; postnuclear whorls a little more than two, the first marked by a rapidly broadening extension of the nuclear keel, sculptured by close, strong, irregular and irregularly spaced, filose, retractive riblets, and by five, smooth, supplementary keels on each side of the main keel, these keels widening, with the addition of intercalated, granular keels on the last whorl numbering about 16, eight or nine appearing on the rounded base and entering into the rather wide, perspective umbilicus, the spacing being rather even, but wider on the upper surface and narrowing toward the umbilicus; last whorl rather evenly rounded, widening rapidly, everywhere marked between the keels by very fine, retractive, growth lines and a few fine, spiral cords; peristome entire, the margin thin, crenulated by the external sculpture; aperture very oblique, suborbicular, flattened on the columellar side. Greatest diameter, 3.97 mm.; least diameter, 2.93 mm.; altitude, 2.2 mm.

*Holotype:* No. 5462, C. A. S. Paleo. Type Coll., from **Coyote Bay, Concepcion Bay, Lower California,** in about two fathoms; collected by Fred Baker, 1921.

The species resembles *C. baldridgei* Bartsch[9] in size, but is differently sculptured. It is larger and more depressed than *Vitrinella decussata* Carpenter,[10] and the decussations are much more limited and less distinct.

It is named for Mr. V. D. P. Spicer of the U. S. S. *Medusa*, known especially for his extensive collections in Samoa.

### 32. **Cyclostrema xantusi** Bartsch

*Cyclostrema xantusi* BARTSCH, Proc. U. S. Nat. Mus., vol. 32, 1907, pp. 171, 172, text figs. 6, *a*, *b*, *c*.

A single specimen, taken in about two fathoms at the northeast anchorage, Monserrate Island, Gulf of California, and four, taken at Cape San Lucas, Lower California, agree well with the description and figures.

### 33. **Circulus cerrosensis** Bartsch

*Circulus cerrosensis* BARTSCH, Proc. U. S. Nat. Mus., vol. 32, 1907, pp. 173, 174, text figs. 9, *a*, *b*, *c*.

Single specimens agreeing well with Bartsch's description and figures were taken at the northeast anchorage, Monserrate Island, in three fathoms, and at Amortajada Bay, San Jose Island in about two fathoms, Gulf of California; and at San Luis Gonzaga Bay, Lower California, in about four fathoms.

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[9] Proc. U. S. Nat. Mus., vol. 39, 1911, pp. 229, 230, pl. 30, figs. 7, 8, 9.

[10] Cat. Mazatlan Shells, 1857, p. 239.

### 34. **Circulus madreënsis** Baker, Hanna and Strong, new species

Plate 23, figures 1, 2, 3

Shell of medium size among the species of this coast, depressed, with a low spire, everywhere marked by strong growth lines, becoming very strong in the umbilical region, shining, white; nuclear whorls nearly 2½, very slightly convex, but with well defined sutures, nearly smooth, the transition to postnuclear sculpture very indistinct; postnuclear whorls nearly two, everywhere sculptured with spiral keels, rather sharp on the upper and peripheral surface, but rounded below, beginning indistinctly on the first whorl and increasing by intercalation, three more prominent appearing on the last whorl, one on the periphery, one above this and a little nearer to it than to the suture, with a third at about one-fourth the distance between the peripheral keel and the umbilicus, with eight less prominent cords between the suture and the first main keel, two between this and the peripheral keel, two less distinct between this and the basal keels, and about 18 irregular and irregularly spaced, low, rounded, spiral cords between the basal keel and the umbilicus; umbilicus perspective, showing all the whorls inside, surrounded by a flaring, funnel-shaped depression extending over three-quarters of the base, this depression being partially covered by a thin callus, extending from the basal lip about two-thirds around the base of the shell and slightly into the umbilicus, this callus marked by a part of the spiral basal cords and by very strong enlargements of the growth lines dipping into the umbilicus; last whorl rather sharply descending for about one-sixth of the last turn; aperture very oblique, suborbicular; peritreme continuous through a very thin callus on the parietal wall; outer lip thin, crenulated by the external sculpture; parietal wall showing the extension of the external sculpture well within the aperture through its thin callus. Greatest diameter, 2.69 mm.; least diameter, 2.06 mm.; altitude, 1.35 mm.

*Holotype:* No. 5469, C. A. S. Paleo. Type Coll., with one mature and six additional immature specimens from **Maria Madre Island, Tres Marias group** off west coast of Mexico; collected by G. D. Hanna and E. K. Jordan, June, 1925.

The species differs from all others described from this coast in its sculpture and especially in the character of the basal and umbilical callus, which is as distinctively sculptured as any portion of the shell. However, the immature specimens show this umbilical callus only slightly or not at all, the umbilicus being large, open and perspective, and the prominent keels are not much more developed than the others.

### 35. **Delphinoidea granti** Baker, Hanna and Strong, new species

Plate 22, figures 4, 5, 6

Shell large, somewhat globose, but flattened above, everywhere marked by very prominent, retractive, more or less arcuate or sinuous growth lines, subdiaphanous, shining, white; nuclear whorls nearly two, depressed, marked by a subcentral, spiral cord with a shallow groove on each side between it and the sutures; postnuclear whorls about 2½, the separation from the nuclear whorls being rather indistinct, with two rather broad, spiral keels, one at the lower suture and one half way between it and the summit, with broader interspaces showing in the first whorl, increased on the last whorl to about 36 narrow, prominent, subequal, but unequally spaced, spiral cords extending from the suture to, and into the umbilicus; interspaces marked by strong, retractive growth lines, distinctly arcuate or sinuous in places; last whorl increasing very rapidly, slightly flattened above, broadly convex below, slightly descending near the aperture and nearly free from the parietal wall, being attached only near the suture; sutures consisting of a very narrow, impressed groove; aperture large, very oblique, subcircular, with a slightly entering convexity on the parietal side; lips thin, crenulated by the external sculpture; peritreme continuous; umbilicus perspective but rather narrow, with the spiral threads showing nearly to the apex. Greatest diameter, 5.09 mm.; least diameter, 3.52 mm.; altitude 2.98 mm.

*Holotype:* No. 5468, C. A. S. Paleo. Type Coll., and one additional shell, from **Cape San Lucas, Lower California;** collected by G. D. Hanna and E. K. Jordan June, 1925.

The species perhaps resembles *Cyclostremella dalli* Bartsch[11] as much as any of the family from this coast but it is more globose, much larger for the same number of whorls and the umbilicus is much narrower.

The species is named for Dr. U. S. Grant IV, Associate Professor of Paleontology, University of California at Los Angeles.

### 36. **Delphinoidea lucasana** Baker, Hanna and Strong, new species

Plate 19, figures 10, 11, 12

Shell very small, rather depressed, everywhere marked by distinct growth lines, transparent, shining, white; nuclear whorls 1½, minute, nearly smooth, convex, separated by a distinct suture; postnuclear whorls two, the first, narrow, and showing the beginnings of minute, indistinct spiral threads near each suture, with a narrow, nearly smooth space between, the second enlarging rapidly horizontally and vertically, showing indistinct extensions of the spiral cords, and an extension of the clear space to the outer lip, with fairly well-defined additions to the lower group reaching nearly to the middle of the base; remainder of the base marked by obsolescent spiral threads nearly to the umbilical edge; umbilicus perspective, showing the well-rounded whorls nearly or quite to the apex; aperture nearly circular, peristome continuous, spreading in a well-defined callus in the columellar region; lips thin, showing the external sculpture within. Greatest diameter, 1.54 mm.; least diameter, 1.12 mm.; altitude, .78 mm.

*Holotype:* No. 5460, C. A. S. Paleo. Type Coll., and four additional specimens from Cape San Lucas, Lower California; collected by G. D. Hanna and E. K. Jordan, June, 1925.

The species somewhat resembles *Vitrinella ponceliana* de Folin,[12] which evidently belongs to the genus *Delphinoidea*, but that species seems to be more heavily sculptured, and to have the spiral threads much more discrete and extending over the whole shell. The four

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[11] Proc. U. S. Nat. Mus., vol. 39, p. 232, pl. 40, fig. 10–12.

[12] Les Méléagrinicoles, 1867, p. 51, pl. 5, fig. 7.

shells mentioned are all less mature, but all follow rather closely the sculpturing of the holotype, with some variation in the width of the two groups of spiral threads. All show the clear space between the two groups of threads and all show the obsolescence of the threads on the umbilical portion of the base. The threads are so indistinct in some specimens that they can be recognized only in groups.

### 37. **Delphinoidea spiritualis** Baker, Hanna and Strong, new species

Plate 21, figures 1, 2, 3

Shell minute, moderately elevated, with indistinct growth lines, translucent, white; nuclear whorls about 1¼, smooth; postnuclear whorls three, the first enlarging very slightly, the last two rather rapidly, the first showing three rather broad, rounded, spiral threads, the second five, the last about 15, nearly even and evenly spaced, with interspaces about half as broad as the threads, the threads extending over the base and showing on the separate whorls within the funnel-shaped perspective umbilicus; sutures moderate; aperture sub-circular, showing the external sculpture within, but at no point showing a distinct keel; peristome continuous, scarcely straightened or thickened on the columellar portion. Greatest diameter, 1.20 mm.; least diameter, 1.01 mm.; altitude .97 mm.

*Holotype:* No. 5463, C. A. S. Paleo. Type Coll., and two additional specimens, were taken at **Espiritu Santo Island, Gulf of California** by Fred Baker in 1921.

The species seems most like "*?Circulus*" *rossellinus* Dall, from the Coronados Islands near San Diego, California, but, so far as can be judged from the meager description, it is smaller for the same number of whorls, more elevated and probably has fewer spiral threads.

### 38. **Delphinoidea stephensæ** Baker, Hanna and Strong, new species

Plate 21, figures 4, 5, 6

Shell small, scarcely depressed, with indistinct growth lines, translucent, white; nuclear whorls 1½, rather prominent, smooth and shining; postnuclear whorls about 2½, everywhere marked by minute, narrow, rounded, spiral threads, with narrower interspaces, all nearly equal and equally spaced; first turn showing about nine threads, second about 15, and the last about 50; sutures deeply impressed; aperture subcircular, with a slight convexity at the well rounded parietal wall, showing the external sculpture very distinctly within; umbilicus narrow but perspective, showing at least two turns within. Greatest diameter, 1.66 mm.; least diameter, 1.32 mm.; altitude, 1.60 mm.

*Holotype:* No. 5464, C. A. S. Paleo Type Coll., from **Maria Madre Island, Tres Marias group** off the west coast of Mexico; collected by G. D. Hanna and E. K. Jordan, June, 1925.

This form resembles *D. spiritualis* of this paper, but is more globose, has a narrower umbilicus and many more spiral threads.

The species is named for Mrs. Kate Stephens of the San Diego Society of Natural History.

### 39. **Scissilabra monile** (Carpenter)

Plate 19, figures 7, 8, 9

*Vitrinella monile* Carpenter, Cat. Mazatlan Shells, 1857, p. 240.—Tryon, Man. Conch., vol. 10, 1887, p. 102, pl. 34, fig. 37.

A single specimen taken at Coronados Island, Gulf of California, agrees with Carpenter's description, in which he notes the peculiar sinuation of the lip, characteristic of *Scissilabra*.

### 40. **Teinostoma amplectans** Carpenter

Plate 23, figures 4, 5, 6

*Teinostoma amplectans* Carpenter, Cat. Mazatlan Shells, 1857, pp. 253, 254.—Tryon, Man. Conch., vol. 10, 1887, p. 104, pl. 35, fig. 60, 61.—See also Pilsbry's discussion of *Ethalia* and *Teinostoma*, Man. Conch., vol. 11, pp. 457, 458.

Taken at Cape San Lucas; La Paz, in three to four fathoms; Coyote Bay, Concepcion Bay, in two fathoms, Puerto Escondido, in three fathoms, all of Lower California; west anchorage, San Jose Island, and Isthmus Bay, Espiritu Santo Island, Gulf of California.

### 41. **Teinostoma regularis** (C. B. Adams)

Plate 22, figures 1, 2, 3

*Vitrinella regularis* C. B. Adams, Cat. Panama Shells. Ann. Lyc. Nat. Hist., New York, vol. 5, 1852, pp. 412, 540 (separate p. 188).

Two shells, one only half grown, taken at Maria Madre Island, Tres Marias group, fit closely the meager description of a single shell taken at Panama.

## PLATE 17

Fig. 1. *Cerithium uncinatum* (Gmelin). Plesiotype, No. 5439, (C. A. S.), Maria Madre Island, Mexico. Length, 25.5 mm.; diameter, 12.5 mm.; p. 226.

Fig. 2. *Cerithium maculosum* Kiener. Plesiotype, No. 5440, (C. A. S.), San Francisco Island, Gulf of California. Length, 46 mm.; diameter, 20.5 mm.; p. 225.

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Fig. 4. *Cerithidea albonodosa* Carpenter. Plesiotype, No. 5447, (C. A. S.), San Luis Gonzaga Bay, Gulf of California. Length, 31 mm.; diameter, 12.7 mm.; p. 227.

Fig. 5. *Clava gemmata* (Hinds). Plesiotype, No. 5442, (C. A. S.), Maria Madre Island, Mexico. Length, 30 mm.; diameter, 11.5 mm.; p. 226.

Fig. 6. *Potamides sculptus* (Sowerby). Plesiotype, No. 5443, (C. A. S.), San Marcos Island, Gulf of California. Length, 19.5 mm.; diameter, 7 mm.; p. 227.

Fig. 7. *Cerithium alboliratum* Carpenter. Plesiotype, No. 5425, (C. A. S.), Cape San Lucas, Lower California. Length, 3.8 mm.; diameter, 1.4 mm.; p. 225.

Plate 18

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Fig. 2. *Cerithidea montagnei* (d'Orbigny). Plesiotype, No. 5445, (C. A. S.), San Ignacio Lagoon, Lower California. Length, 47.5 mm.; diameter, 15.5 mm.; p. 227.

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Fig 4. *Metaxia convexa* (Carpenter). Plesiotype, No. 5448, (C. A. S.), Maria Madre Island, Mexico. Length, 2.82 mm.; diameter, .79 mm.; p. 224.

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Fig. 6. *Cerithiopsis kinoi* Baker, Hanna & Strong., n. sp. Holotype, No. 5451, (C. A. S.), Cape San Lucas, Lower California. Length, 3.25 mm.; diameter, .99 mm.; p. 221.

Fig 7. *Cerithiopsis subgloriosa* Baker, Hanna & Strong, n. sp. Holotype, No. 5453 (C. A. S.), Amortajada Bay, San Jose Island, Gulf of California. Length, 3.93 mm.; diameter, 1.19 mm.; p. 218.

Fig. 8. *Metaxia diadema* Bartsch. Plesiotype, No. 5449, (C. A. S.), Lower California. Length, 6.4 mm.; diameter, 1.8 mm.; p. 224.

PLATE 19

Fig. 1. *Cerithiopsis pupiformis* Carpenter. Plesiotype, No. 5454, (C. A. S.), Cape San Lucas, Lower California. Length, 1.77 mm.; diameter, .78 mm.; p. 218.

Fig. 2. *Cerithiopsis porteri* Baker, Hanna & Strong, n. sp. Holotype, No. 5455, (C. A. S.), Gulf of California. Length, 2.17 mm.; diameter, .596 mm.; p. 222.

Fig. 3. *Cerithiopsis tuberculoides* Carpenter. Plesiotype, No. 5456, (C. A. S.), Cape San Lucas, Lower California. Length, 2.39 mm.; diameter, .83 mm.; p. 219.

Fig 4. *Cerithiopsis bristolæ* Baker, Hanna & Strong, n. sp. Holotype, No. 5457, (C. A. S.), Cape San Lucas, Lower California. Length, 1.17 mm.; diameter, .89 mm.; p. 219.

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Fig. 6. *Cerithiopsis kinoi* Baker, Hanna & Strong, (subspecies?) Plesiotype, No. 5452, (C. A. S.), Cape San Lucas, Lower California. Length, 2.04 mm.; diameter, .83 mm.; p. 222.

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## Plate 20

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## Plate 21

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Figs, 4, 5, 6. *Delphinoidea stephensæ* Baker, Hanna & Strong, n. sp. Holotype, No. 5464, (C. A. S.), Maria Madre Island, Mexico. Diameter, 1.66 mm.; altitude, 1.60 mm.; p. 238.

Figs 7, 8, 9. *Cyclostrema mariæ* Baker, Hanna & Strong, n. sp. Holotype, No. 5465, (C. A. S.), Maria Madre Island, Mexico. Diameter, 2.28 mm.; altitude, 1.24 mm.; p. 234.

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## Plate 22

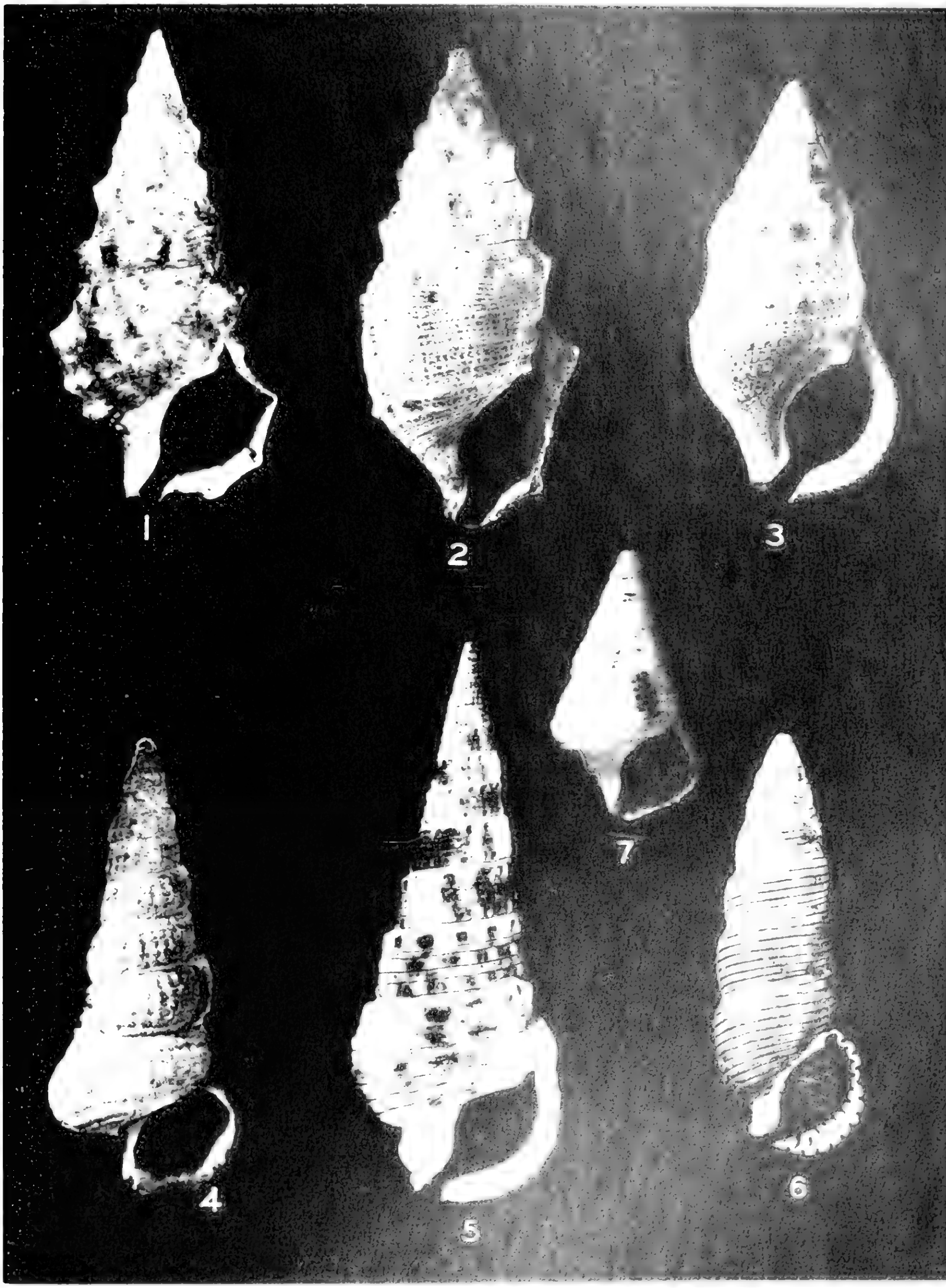
Figs. 1, 2, 3. *Teinostoma regularis* (C. B. Adams). Plesiotype, No. 5467, (C. A. S.), Maria Madre Island, Mexico. Diameter, 2.03 mm.; least diameter, 1.44 mm.; altitude, 1.19 mm.; p. 239.

Figs. 4, 5, 6. *Delphinoidea granti* Baker, Hanna & Strong, n. sp. Holotype, No. 5468, (C. A. S.), Cape San Lucas, Lower California. Diameter, 5.09 mm.; altitude, 2.98 mm.; p. 236.

## Plate 23

Figs. 1, 2, 3. *Circulus madreënsis* Baker, Hanna & Strong, n. sp. Holotype, No. 5469, (C. A. S.), Maria Madre Island, Mexico. Diameter, 2.69 mm.; altitude, 1.35 mm.; p. 236.

Figs. 4, 5, 6. *Teinostoma amplectans* Carpenter. Plesiotype, No. 5470, (C. A. S.), La Paz, Lower California. Diameter, 2.55 mm.; least diameter, 1.80 mm.; altitude, 1.20 mm.; p. 239.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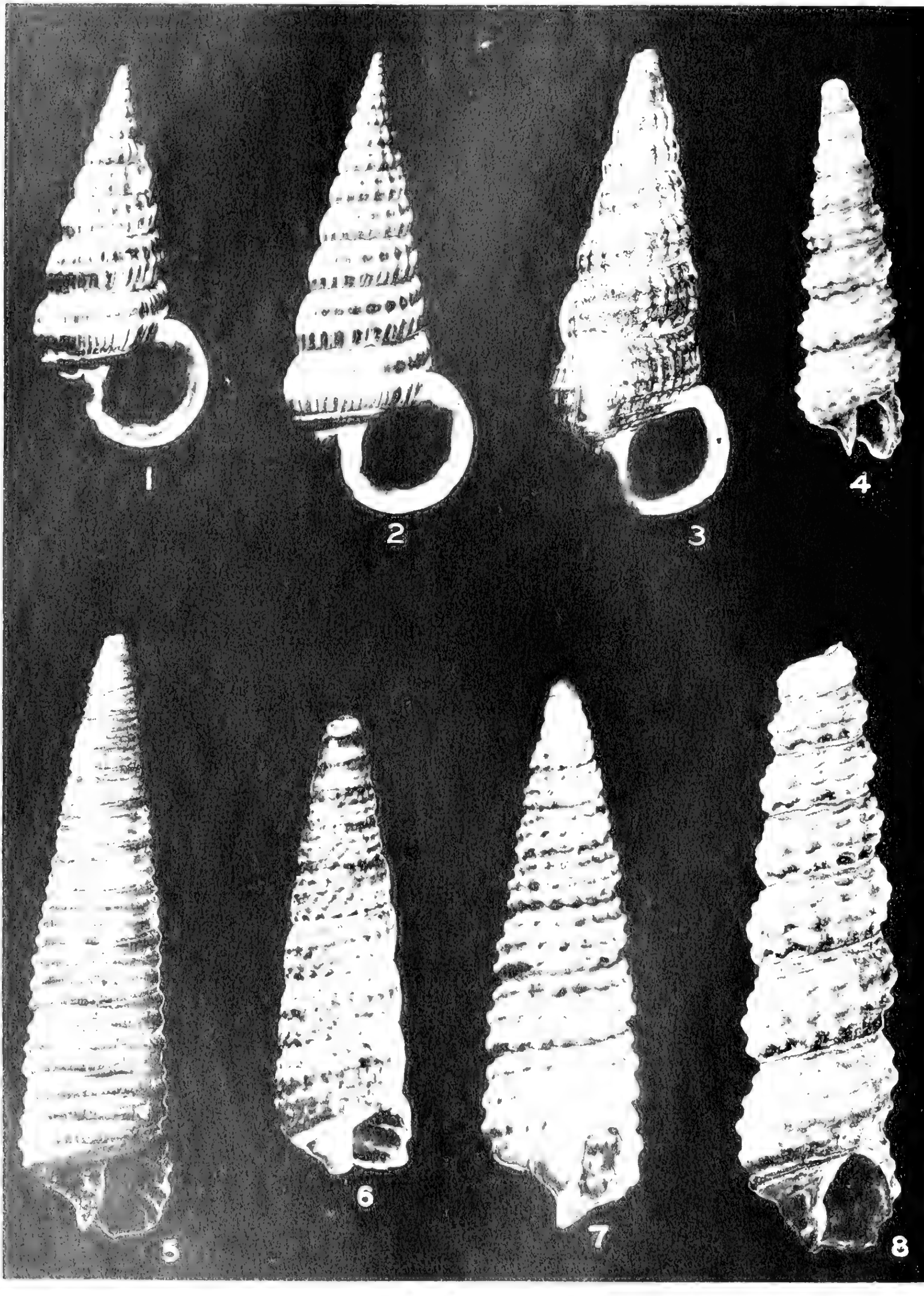
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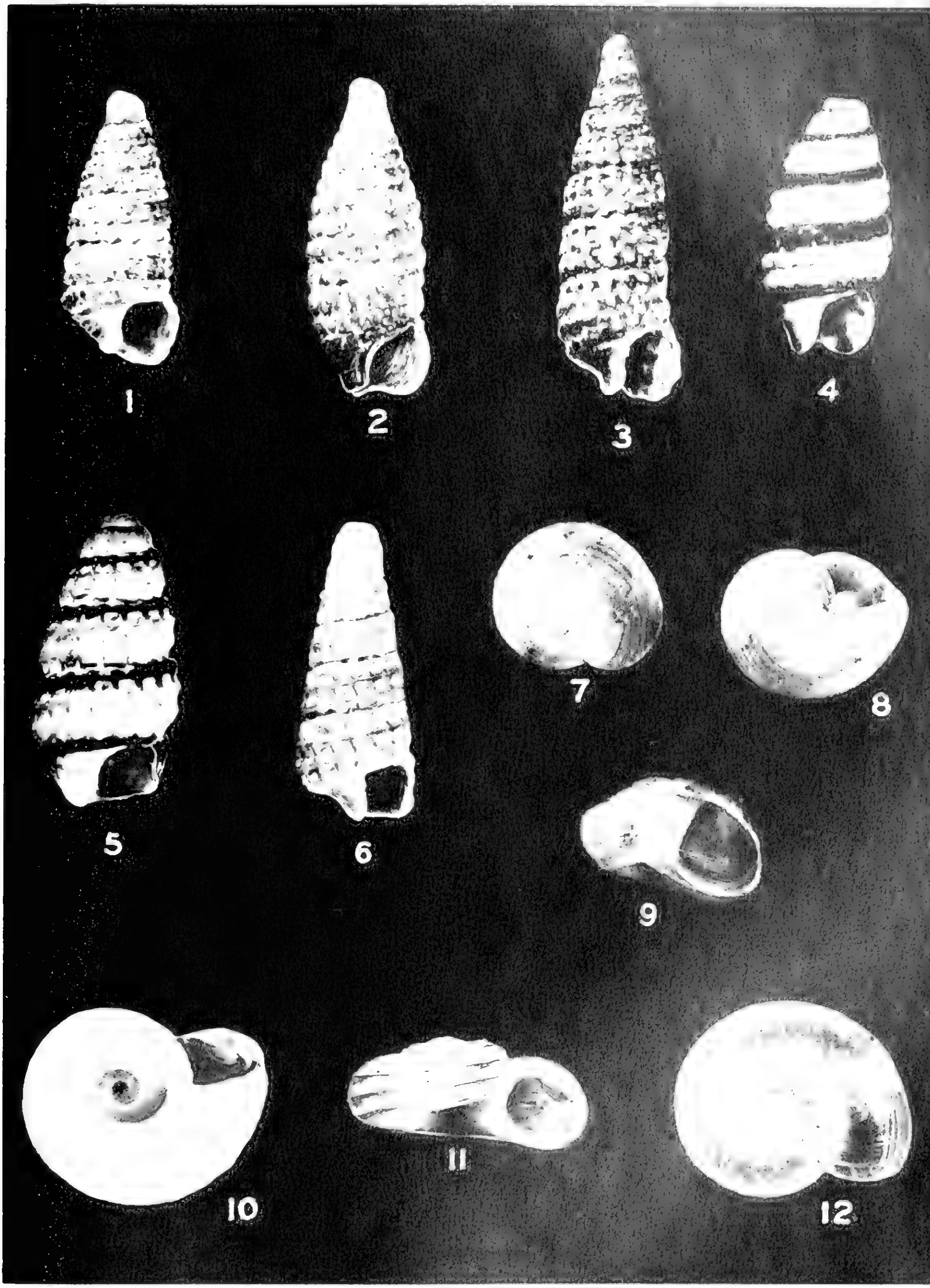
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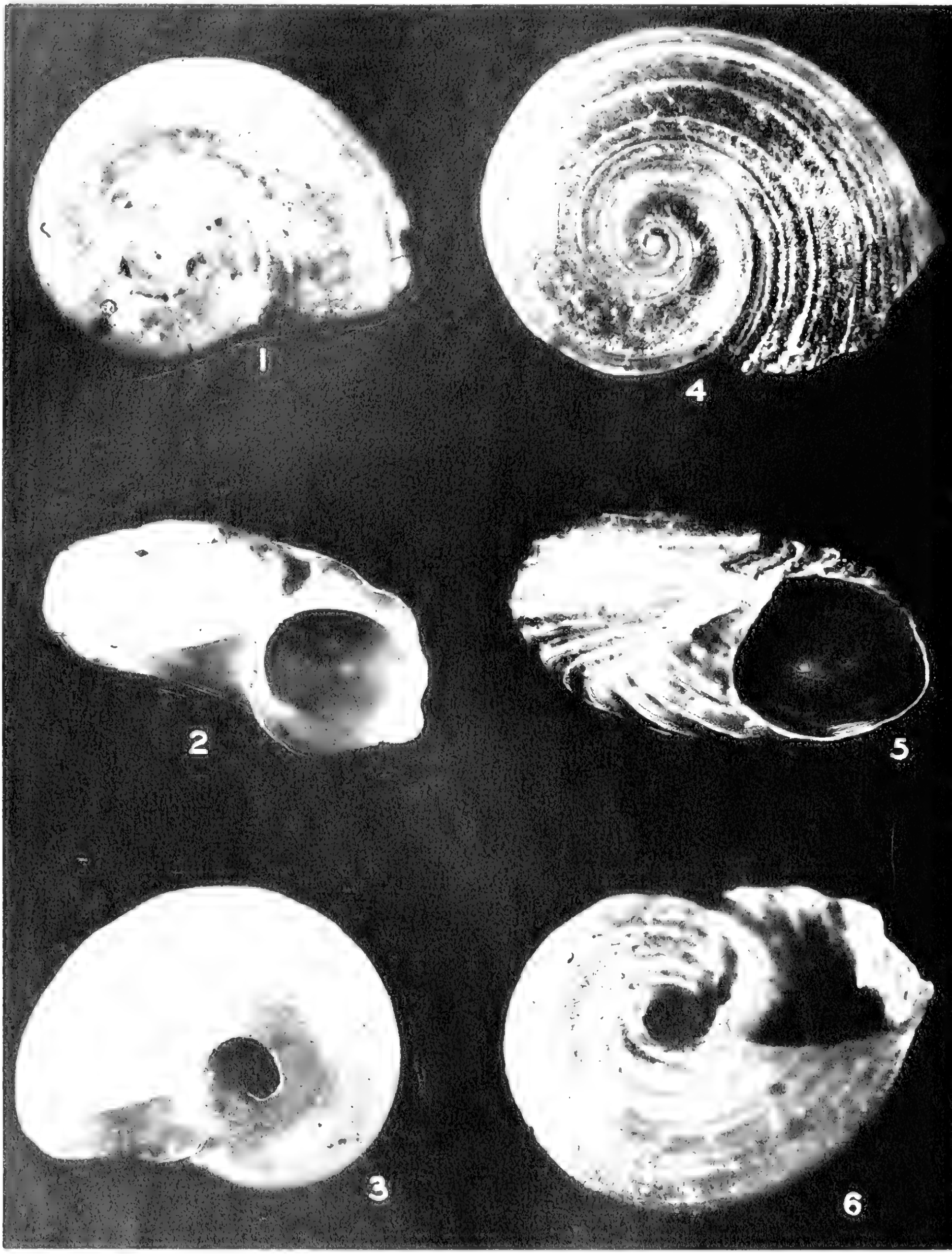
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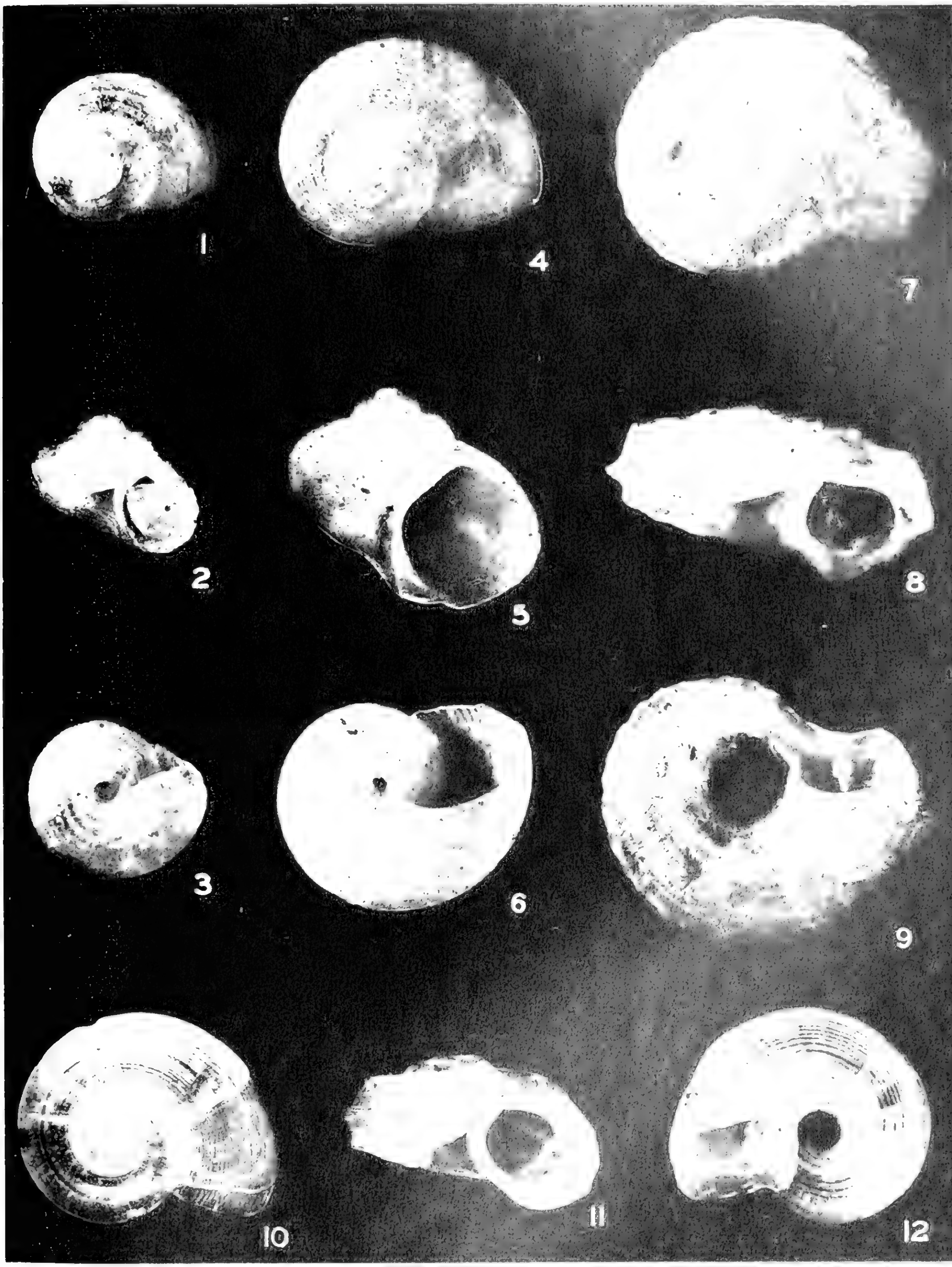
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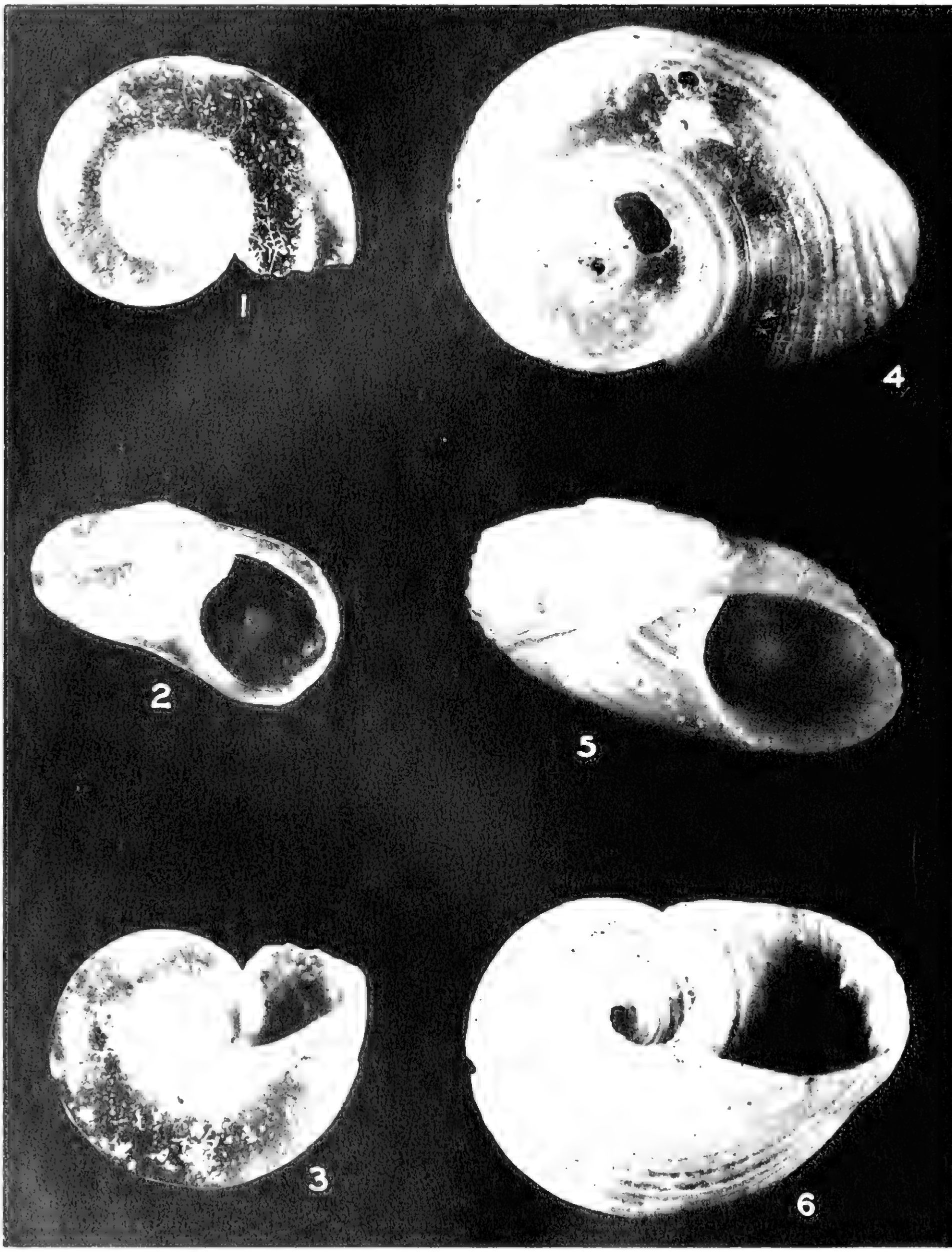
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**No. 16**

## COLUMBELLIDÆ FROM WESTERN MEXICO *

BY

FRED BAKER
*San Diego, California*

G. D. HANNA
*Curator, Department of Paleontology*
*California Academy of Sciences*

AND

A. M. STRONG
*Los Angeles, California*

The present paper follows the plan of preceding ones published in the Proceedings of the Academy. There are listed all of the species of the family Columbellidæ which were obtained by the expedition to the Gulf of California in 1921, and those to various islands and points on the Peninsula in 1922 and 1925.[1] References are given to original descriptions and, when possible, to figures. Except in cases where the original records have been verified, synonyms have not been quoted.

The family Columbellidæ is represented on the west coast of North America by about 100 species. In so large a number it is

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[1] For general accounts of these expeditions see:
Slevin, J. R. Proc. Calif. Acad. Sci., ser. 4, vol. 12, no. 6, 1923, pp. 55–72.—Hanna, G. D. Proc. Calif. Acad. Sci., ser. 4, vol. 14, no. 12, 1925, pp. 217–275, pls. 15–19.—Hanna, G. D. Proc. Calif. Acad. Sci., ser. 4, vol. 15, no. 1, 1926, pp. 1–113, pls. 1–10.

difficult to find combinations of characters whereby sharp distinctions can be made between genera. However, most of the species fall readily into the recognized groups. A key to the genera which we now accept as inhabitants of western waters is presented below.

*Key to genera of west American Columbellidæ*

1 Aperture with both anterior and posterior canal . . . . . . . . . . . . . . . . . . *Bifurcium*
1 Aperture with posterior canal only
  2 Shell coniform, aperture long and narrow . . . . . . . . . . . . . . . . . . . . *Parametaria*
  2 Shell strombiform to ovate, outer lip dentate in the adult
    3 Shell smooth except for spiral striae on base and canal
      4 Spire short, shell thick and heavy . . . . . . . . . . . . . . . . . . . . . . . . . . . *Pyrene*
      4 Spire as long or longer than aperture, shell small . . . . . . . . . . . . . . . *Mitrella*
    3 Shell with axial and spiral sculpture . . . . . . . . . . . . . . . . . . . . . . . . . . *Anachis*
        5 Shell subcylindric, columella and canal short . . . . . . . . . . . . . . . . *Aesopus*
        5 Body whorl swollen, spire tapering, sharp . . . . . . . . . . . . . . . . . *Strombina*
        5 Shell bucciniform, lip sharp or slightly thickened
          6 Shell with both axial and spiral sculpture . . . . . . . . . . . . . . . *Amphissa*
          6 Shell with spiral sculpture only . . . . . . . . . . . . . . . . . . . . *Cosmioconcha*

Many of the western species belonging to this family were described as *Columbella* and their allocation in accordance with the modern usage of genus-names is difficult. Some of these names which have been in common use are found upon critical examination to have genotypes which differ widely from western species. *Columbella* itself is now restricted to shells which have strong spiral sculpture, and is not represented in the fauna. Similarly, the genus *Nitidella* is restricted to species which have a plicate columella; Dall's statement that the plications were obsolete in some forms is hardly sufficient to warrant placing them in the group. *Alia* and *Astyris* are found to have different genotypes from those assigned to them by Dall, and the names cannot be used in the sense in which he employed them. The genera, *Mitrella* and *Anachis* as here used might be divided, but to do so would require extensive research, the material for which is not available. Tryon, in the Manual of Conchology, used the name *Seminella* for some of the small species which we have placed in *Anachis*.

### 1. **Bifurcium uncinatum** (Sowerby)

*Columbella uncinata* SOWERBY, Proc. Zool. Soc., 1832, p. 114.—REEVE, Conch. Icon., vol. 11, 1869, pl. 23, species 142.

*Columbellina uncinata* (SOWERBY), TRYON, Man. Conch., vol. 5, 1883, p. 196, pl. 63, fig. 64.

Many specimens were dredged off Maria Madre Island, Tres Marias group, in about 10 fathoms.

### 2. **Parametaria dupontii** (Kiener)

*Conus dupontii* Kiener, Icon. Coq. Viv., 1850, species 6.

*Meta cedonulli* Reeve, Conch. Icon., vol. 11, 1859, pl. 1, species 3.

*Meta dupontii* (Kiener), Reeve, op. cit., species 6.

*Meta philippinarum cedo-nulli* Reeve, Tryon, Man. Conch., vol. 5, 1883, p. 183, pl. 60, fig. 84.

*Parametaria dupontii* (Kiener), Dall, Nautilus, vol. 30, 1916, p. 25.

Specimens were obtained at almost all collecting stations in the Gulf of California, and as far south as Maria Magdalena Island, Tres Marias group.

### 3. **Pyrene fuscata** (Sowerby)

Plate 24, figure 2

*Columbella fuscata* Sowerby, Proc. Zool. Soc., 1832, p. 117.—Reeve, Conch. Icon., vol. 11, 1858, pl. 2, species 9.—Tryon, Man. Conch., vol. 5, 1883, p. 105, pl. 42, fig. 19.

Specimens were collected at nearly every point in the Gulf of California visited by the Academy's expeditions.

### 4. **Pyrene major** (Sowerby)

*Columbella major* Sowerby, Proc. Zool. Soc., 1832, p. 119.—Carpenter, Maz. Cat., 1857, p. 489.—Reeve, Conch. Icon., vol. 11, 1858, pl. 2, species 7.—Tryon, Man. Conch., vol. 5, 1883, p. 104, pl. 42, figs. 7, 8.

Specimens from the Tres Marias Islands are placed in this species with some hesitation. Carpenter separated it from *P. strombiformis* Lamarck, principally by the sculpture on the epidermis. It will take many more specimens than are available in the Academy's collection to determine its standing as a species or variety.

### 5. **Pyrene strombiformis** (Lamarck)

Plate 24, figure 1

*Columbella strombiformis* Lamarck, Anim. s. Vert., vol. 7, 1822, p. 293.—Carpenter, Maz. Cat., 1857, p. 490.—Reeve, Conch. Icon., vol. 11, 1858, pl. 2, species 8.—Tryon, Man. Conch., vol. 5, 1883, p. 104, pl. 42, fig. 5.

Specimens were collected at Mulege, salt works on Carmen Island, Punta Arena, and Ceralvo Island.

### 6. **Mitrella millepunctata** (Carpenter)

Plate 24, figure 9

?*Nitidella millepunctata* CARPENTER, Ann. & Mag. Nat. Hist., ser. 3, vol. 14, 1864, p. 47.—TRYON, Man. Conch., vol. 5, 1883, p. 115.

One specimen of this hitherto unfigured species was collected at Puerto Escondido, and several at San Evaristo Bay.

### 7. **Mitrella ocellata** (Gmelin)

Plate 24, figure 3

*Voluta ocellata* GMELIN, Syst. Nat., ed. 13, vol. 8, 1791, p. 3455.

*Buccinum cribrarium* LAMARCK, Anim. s. Vert., vol. 7, 1822, p. 274.—(?) QUOY & GAIMARD, Voy. *Astrolabe*, Zool., vol. 2, 1832, p. 421, pl. 30, figs. 21, 22. ". . . l' île de l' Ascension."

*Nitidella cribraria* LAMARCK, CARPENTER, Maz. Cat., 1857, p. 487.

*Columbella cribraria* LAMARCK, REEVE, Conch. Icon., vol. 11, 1858, pl. 13, species 62.

*Mitrella cribraria* LAMARCK, TRYON, Man. Conch., vol. 5, 1883, p. 122, pl. 48, figs. 73, 74, 75.

In this case we have followed the recent practice of considering that the species which occurs in the West Indies is the same as that found in the Gulf of California. Specimens were collected at nearly every point in the Gulf of California visited by the Academy expeditions.

### 8. **Mitrella dorma** Baker, Hanna & Strong, new species

Plate 24, figure 6

Shell small, strombiform, with a sharp, pointed spire, whorls seven, rounded, with distinct, impressed suture, smooth, except for nearly vertical, uneven, fine growth lines and microscopic spiral striations and, on the lower part of the body whorl and canal, about ten fine spiral grooves; color bright chestnut, with a very faint, microscopic net work of lighter lines; aperture small, rather narrow; outer lip drawn forward in the middle, thickened within, with six faint plications; columella nearly straight, obliquely truncated anteriorly, bearing six spirally elongated denticles of which the lower three are much the stronger, bordered by a raised edge; body with a thin wash of enamel; canal short, deeply notched, slightly recurved. The type is one of 110 specimens from Angeles Bay on the Gulf coast of Lower California and measures: length of shell, 6 mm.; of last whorl, 4 mm.; maximum diameter, 3 mm.

*Holotype:* No. 5817 Calif. Acad. Sci. Paleo. Type Coll., from **Angeles Bay, Lower California (Gulf Coast)**; collected by Fred Baker in 1921. Specimens were also collected at Smith, Granite and San Jose Islands.

In shape this species is very similar to some specimens of *Mitrella carinata californiana* Gaskoin, but it is a smaller shell, and lacks the varied color pattern present in that species. *Mitrella millepunctata* Carpenter is about the same size, but it is a more slender and lighter colored shell with a regular pattern of brown dots.

### 9. **Anachis bartschi** Dall

Plate 24, figure 11

*Anachis bartschi* DALL, Proc. U. S. Nat. Mus., vol. 54, 1918, p. 233.

Two immature specimens from San Marcos Island seem to belong to this hitherto unfigured species.

### 10. **Anachis coronata** (Sowerby)

Plate 24, figure 5

*Columbella coronata* SOWERBY, Proc. Zool. Soc., 1832, p. 114.—REEVE, Conch. Icon., vol. 11, 1858, pl. 6, species 29.

*Anachis coronata* SOWERBY, CARPENTER, Maz. Cat., 1857, p. 508.—TRYON, Man. Conch., vol. 5, 1883, p. 153, pl. 54, figs. 36, 37.

This species was collected at La Paz, Agua Verde Bay, San Jose Island, San Luis Gonzaga Bay, Isla Partida, San Luis Island, Puerto Escondido and Patos Island.

### 11. **Anachis incerta** (Stearns)

*Nitidella incerta* STEARNS, Nautilus, vol. 6, 1892, p. 88; Proc. U. S. Nat. Mus., vol. 16, 1893, p. 390, pl. 51, fig. 6

One adult and several young specimens were dredged at Maria Madre Island, Tres Marias group. The strength of the "close set, rounded, longitudinal ribs" and color pattern is very variable. It would have been difficult to identify the species from the description of Stearns' type from the Galapagos Islands, but a large series in the Lowe collection contains specimens agreeing exactly with the spirally banded type and with the delicately mottled Maria Madre specimens.

### 12. **Anachis milium** (Dall)

*C.* [*olumbella*] *milium* DALL, Nautilus, vol. 30, 1916, p. 26.

*Columbella parva* SOWERBY, Proc. Zool. Soc., 1844, p. 52. (Not "*Buccinum*" *parvum* LEA, 1841.)—REEVE, Conch. Icon., vol. 11, 1858, pl. 20, species 113.

*Seminella parva* (SOWERBY), TRYON, Man. Conch., vol. 5, 1883, p. 168, pl. 57, figs. 3, 4.

A single specimen was collected at the salt works on Carmen Island.

### 13. **Anachis pygmæa** (Sowerby)

*Columbella pygmæa* Sowerby, Proc. Zool. Soc., 1832, p. 119.—Reeve, Conch. Icon., vol. 11, 1858, pl. 22, species 128.

*Anachis pygmæa* (Sowerby), Carpenter, Maz. Cat., 1857, p. 510.

*Seminella pygmæa* (Sowerby), Tryon, Man. Conch., vol. 5, 1883, p. 166, pl. 56, figs. 91, 92.

Two specimens were collected at La Paz, and about 20 at Maria Madre Island, Tres Marias group.

### 14. **Anachis spadicea** (Philippi)

*Columbella spadicea* Philippi, Zeit. für Mal., 1846, p. 54.—Reeve, Conch. Icon., vol. 11, 1858, pl. 21, species 123.

*Seminella spadicea* (Philippi), Tryon, Man. Conch., vol. 5, 1883, p. 168, pl. 57, fig. 6.

Six specimens were collected at Isla Danzante in the Gulf of California.

### 15. **Anachis subturrita** Carpenter

*Anachis subturrita* Carpenter, Proc. Calif. Acad. Sci., vol. 3, 1866, p. 223.—Oldroyd, Stanford Univ. Publ., Geol. Sci., vol. 2, pt. 1, 1927, p. 270.

*Seminella subturrita* (Carpenter), Tryon, Man. Conch., vol. 5, 1883, p. 178, pl. 58, fig. 47

*Anachis petravis*, Dall, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 250.

Ten specimens dredged at Maria Madre Island, Tres Marias group, seem to be identical with the California species.

### 16. **Anachis tincta** Carpenter

Plate 24, figure 8

? *Anachis tincta* Carpenter, Ann. & Mag. Nat. Hist., vol. 14, 1864, p. 49.

*Seminella tincta* (Carpenter), Tryon, Man. Conch., vol. 5, 1883, p. 178.

Several specimens from Cape San Lucas, the type locality, seem to agree with the description of this minute species, hitherto unfigured.

### 17. **Anachis vexillum** (Reeve)

*Columbella vexillum* Reeve, Conch. Icon., vol. 11, 1858, pl. 12, species 57.

*Anachis vexillum* Reeve, Tryon, Man. Conch., vol. 5, 1883, p. 119, pl. 47, fig. 54.

A single specimen was collected at Georges Island. This seems to be a valid and easily recognizable species.

## 18. **Anachis treva** Baker, Hanna & Strong, new species

Plate 24, figure 4

Shell ovate, shining, flesh colored, with a spiral band of irregular, and irregularly spaced chestnut spots on the periphery, a second row of smaller dots on the base, and a narrow band of fine, axial, chestnut lines next to the suture; nucleus small, blunt, of about two smooth whorls; subsequent whorls six, well rounded; sutures distinct; sculpture of nine or ten low, rounded, nearly vertical axial ribs which are very faint on the upper whorls, but gradually grow stronger toward the aperture; base and canal with fine, closely spaced, spiral grooves, which cross both ribs and interspaces; aperture small, in the adult with a varicose rib just back of the edge of the outer lip, and eight strong denticles on the inside; columella short, straight, obliquely truncate anteriorly with a raised margin and three obscure denticles; body covered with a thin wash of enamel; canal short, deeply notched, hardly recurved. The type is one of more than one hundred, mostly immature, specimens dredged off Maria Madre Island, Tres Marias group and measures: length of shell 9.5 mm.; of last whorl, 7 mm.; maximum diameter, 4.5 mm.

*Holotype:* No. 5820, Calif. Acad. Sci. Paleo. Type Coll., from **Maria Madre Island, Tres Marias** group, Mexico.

In color and general shape this species resembles *Columbella varia* Sowerby,[2] found along the west coast from Panama north to the Gulf of California, but that is a larger and more strongly marked form. Neither species should be confused with *Columbella varians* Sowerby,[3] which was described from the Galapagos Islands, but is possibly confined to Hawaii and other localities far to the westward.

## 19. **Strombina gibberula** (Sowerby)

*Columbella gibberula* SOWERBY, Proc. Zool. Soc., 1832, p. 115.—REEVE, Conch. Icon., vol. 11, 1858, pl. 13, species 61.

*Strombina gibberula* (SOWERBY), TRYON, Man. Conch., vol. 5, 1883, p. 184, pl. 60, fig. 90.

This species was collected at Puerto Escondido, San Jose Island, Las Animas Bay, Cape San Lucas and dredged in large numbers off Maria Madre Island, Tres Marias group.

## 20. **Strombina maculosa** (Sowerby)

*Columbella maculosa* SOWERBY, Proc. Zool. Soc., 1832, p. 116.—REEVE, Conch. Icon., vol. 11, 1858, pl. 4, species 19.

*Strombina maculosa* (SOWERBY), CARPENTER, Maz. Cat., 1857, p. 513.—TRYON, Man. Conch., vol. 5, 1883, p. 186, pl. 60, fig. 97.

This species was collected at Puerto Escondido, San Evaristo Bay, San Francisquito Bay and at Maria Madre Island, Tres Marias group.

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[2] Sowerby, G. B. Proc. Zool. Soc. London, 1832, p. 116.

[3] Sowerby, G. B. Proc. Zool. Soc. London, 1832, p. 118.

### 21. **Strombina pulcherrima** (Sowerby)

*Columbella pulcherrima* Sowerby, Proc. Zool. Soc., 1832, p. 113.—Reeve, Conch. Icon., vol. 11, 1858, pl. 3, species 10.

*Strombina pulcherrima* (Sowerby), Tryon, Man. Conch., vol. 5, 1883, p. 185, pl. 60, fig. 96.

Three specimens of this species were dredged off Maria Madre Island, Tres Marias group.

### 22. **Aesopus eurytoides** (Carpenter)

Plate 24, figure 10

*Truncaria eurytoides* Carpenter, Ann. & Mag. Nat. Hist., vol. 14, 1864, p. 47.

*Aesopus arestus* Dall, Proc. U. S. Nat. Mus., vol. 56, 1919, p. 332.

*Aesopus eurytoides* (Carpenter), Oldroyd, Stanford Univ. Publ., Geol. Sci., vol. 2, pt. 1, 1927, p. 278.

A large series from Cape San Lucas, the type locality, shows considerable variation in color and strength of axial ribs. In the lot there are specimens which agree in every way with the description of *arestus* which came from Magdalena Bay.

### 23. **Aesopus sanctus** Dall

Plate 24, figure 7

*Aesopus sanctus* Dall, Proc. Biol. Soc. Wash., vol. 32, 1919, p. 250.—Oldroyd, Stanford Univ. Publ., Geol. Sci., vol. 2, pt. 1, 1927, p. 279.

Eight specimens from Cape San Lucas seem to be identical with the California species.

### 24. **Amphissa lyrta** Baker, Hanna & Strong, new species

Plate 15, figure 1 (See Vol. XXIII, No. 14)

Shell small, bucciniform, with a smooth nucleus of one whorl and six subsequent, roundly shouldered, sculptured whorls; color yellowish-brown, with a darker, brownish band on the periphery of the whorls; spiral sculpture of close-spaced, low, rounded cords, of which six appear between the sutures and ten on the base and canal; axial sculpture of equally close-spaced low, somewhat undulated, very slightly protractive ribs; the intersection of the cords and ribs forming rounded tubercles becoming obsolete on the base; aperture oval; outer lip thin, sharp-edged, showing the sculpture within; columella short, nearly straight, obliquely truncate anteriorly; body with a very thin wash of enamel which scarcely obscures the sculpture; canal short, straight; operculum small, thin, yellowish. The type is one of ten specimens from the Isla Partida in the Gulf of California and measures: length of shell, 9 mm.; of last whorl, 6 mm.; maximum diameter, 4 mm.

*Holotype:* No. 5816, Calif. Acad. Sci., Paleo. Type Coll., from **Isla Partida, Gulf of California**; collected by Fred Baker, 1921. Eight additional specimens were collected at Granite Island, two at San Luis Gonzaga Bay and one at Coronados Island.

This is not only the smallest of the species placed in the genus, but the most southerly in its distribution. In all the specimens examined the sculpture is very constant, but there is considerable variation in the color, some of them being nearly white, while in others the brown band is expanded to cover the upper half of the whorl.

## PLATE 24

Fig. 1. *Pyrene strombiformis* (Lamarck). Plesiotype No. 5827, C. A. S. Mulege Bay, Gulf of California. Length, 26 mm.; diameter, 16.6 mm.; p. 247.

Fig. 2. *Pyrene fuscata* (Sowerby). Plesiotype No. 5824, C. A. S. Isla Partida, Gulf of California. Length, 18.2 mm.; diameter, 11.5 mm.; p. 247.

Fig. 3. *Mitrella ocellata* (Gmelin). Plesiotype No. 5819, C. A. S. Georges Island, Gulf of California. Length, 12.8 mm.; diameter, 5.0 mm.; p. 248.

Fig. 4. *Anachis treva* Baker, Hanna & Strong, n. sp. Holotype No. 5820, C. A. S. Maria Madre Island, Mexico. Length, 9.5 mm.; diameter, 4.5 mm.; p. 251.

Fig. 5. *Anachis coronata* (Sowerby). Plesiotype No. 5826, C. A. S. Pa Laz, Lower California. Length, 14.0 mm.; diameter, 6.3 mm.; p. 249.

Fig. 6. *Mitrella dorma* Baker, Hanna & Strong, n. sp. Holotype No. 5817, C. A. S. Angeles Bay, Lower California. Length, 6.0 mm.; diameter, 3 mm.; p. 248.

Fig. 7. *Aesopus sanctus* Dall. Plesiotype No. 7081, C. A. S. Cape San Lucas, Lower California. Length, 4.8 mm.; diameter, 1.6 mm.; p. 252.

Fig. 8. *Anachis tincta* Carpenter. Plesiotype No. 7079, C. A. S. Cape San Lucas, Lower California. Length, 5.8 mm.; diameter, 2.6 mm.; p. 250.

Fig. 9. *Mitrella millepunctata* (Carpenter). Plesiotype No. 7077, C. A. S. San Evaristo Bay, Lower California. Length, 6.5 mm.; diameter, 2.8 mm.; p. 248.

Fig. 10. *Aesopus eurytoides* (Carpenter). Plesiotype No. 7080, C. A. S. Cape San Lucas, Lower California. Length, 6.6 mm.; diameter, 2.3 mm.; p. 252.

Fig. 11. *Anachis bartschi* Dall. Plesiotype No. 7078, C. A. S. San Marcos Island, Gulf of California. Length, 6.4 mm.; diameter, 2.6 mm.; p. 249.


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**PROCEEDINGS**

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**No. 17**

# ON SOME BIRDS RARE IN, OR HITHERTO UNRECORDED FROM, CHIRIQUI PROVINCE, PANAMA*

BY

M. E. McLELLAN DAVIDSON

As a result of several winters' field work in Chiriqui Province, Panama, the writer has accumulated for the California Academy of Sciences a considerable amount of material from hitherto unworked sections of this Province, as well as from the better known areas. In certain instances the species is well known, but has not been recorded previously from Chiriqui; in other cases the species itself is rare throughout its range, and the existence of museum representatives is of interest; and other species have been included in the appended list because the elevation at which the individual was taken is worthy of note.

All the localities mentioned in this paper are in Chiriqui Province, Panama. The name Cerro Punto does not appear on most maps, but it pertains to a mountain and a district lying to the north of the Volcan de Chiriqui. El Banco is on what is marked "Llanos de Cacicón" on the American Geographical Society's map No. N. C.–17, Panama. Chame is the Indian name of a knife ridge just south of Cerro Flores, eastern Chiriqui.

**Collumbigallina minuta elæodes** Todd.—Nos. 33120–22: male and females; December 18 and 23, 1930; El Banco (900 feet). These specimens appear to be the first of the species taken in Chiriqui

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Province. This little ground dove was not detected elsewhere, although Griscom[1] records it as "common" on the Pacific slope of western Panama.

**Claravis mondetoura pulchra** Griscom.—No. 33126: female; January 3, 1931; Cerro Punto (6,000 feet). Here, as elsewhere in the range of the species, the bird is apparently rare. The individual taken was the only one seen, and it was unknown to residents of Cerro Punto.

**Oreopeleia costaricensis** (Lawrence).—No. 33128–30: male and females; January 2 and 6, 1931; Cerro Punto (6,000 feet). No. 38445: male; January 29, 1934; Cerro Azul (5,500 feet), Boquete. W. W. Brown took examples of this species about Boquete and on the Volcan de Chiriqui from 7,000 to 10,000 feet.

**Ajaia ajaja** (Linnæus).—One Roseate Spoonbill was seen from time to time in November, 1929, on a sandbar in the Rabo de Puerco River, near Puerto Armuelles. No specimen was secured.

**Heterocnus cabanisi** (Heine).—No. 32557: male; November 23, 1929; Puerto Armuelles. There appears to be no record of this bird having been taken before this time in Chiriqui.

**Phalacrocorax olivaceus olivaceus** (Humboldt).—No specimens were taken, but individuals of the species were seen at close range on several occasions on the Caldera River, near Boquete (3,800 feet).

**Accipiter striatus velox** (Wilson).—No. 38448: male; February 15, 1934; Horqueta (5,400 feet), Boquete. This is the second specimen taken within the territory.

**Accipiter bicolor bicolor** (Vieillot).—No. 34167: male; November 30, 1931; near San Felix (100 feet). Apparently the bird is not common, but it has been taken previously on the Volcan de Chiriqui.

**Asturina nitida costaricensis** Swann.—No. 33135: male; January 27, 1931; Barriles (4,200 feet), El Volcan. This species does not appear to have been reported from Chiriqui Province.

**Odontriorchis palliatus** (Temminck).—No. 33133: male; February 3, 1931; Barriles (4,200 feet), El Volcan. No. 34165: female; December 3, 1931; near San Felix (100 feet). This rather uncommon species has been collected at Bugaba and on the Volcan de Chiriqui.

**Chordeiles acutipennis micromeris** Oberholser.—No. 34178: male; December 6, 1931; near San Felix (100 feet). No published record of the taking of this bird in Chiriqui has come to my attention.

[1] Bull. Mus. Comp. Zool. Harvard, LXXVIII: 311, 1935.

**Phœthornis adolphi saturatus** Ridgway.—No. 34212: female; November 29, 1931; near San Felix (100 feet). Not hitherto known from Chiriqui.

**Popelairia conversii conversii** (Bourcier).—No. 34214: female; January 3, 1932; Chame (3,200 feet). No record of an earlier take of this species in Chiriqui Province is known to me.

**Crotophaga sulcirostris sulcirostris** Swainson.—No. 34232: female; December 3, 1931; near San Felix (100 feet). Probably this bird is not uncommon in Chiriqui, but it does not seem to have been reported before.

**Crotophaga ani** Linnæus.—No. 32607: female; November 21, 1929; Puerto Armuelles. Nos. 32608–09: females; December 3, 1929; near Concepcion (1,500 feet). Nos. 33177–78: male and female; January 20 and 22, 1931; Barriles (4,200 feet), El Volcan. According to Griscom[2] the Ani has only once previously been taken in this area. It has been recorded, however, from Mina de Chorcha by Salvin[3], as well as from Divala by Bangs.

**Veniliornis oleaginus sanguinolentus** (Sclater).—No. 33193–94: males; January 20 and 24, 1931; Barriles (4,200 feet), El Volcan. A rare bird at this elevation and on the Pacific slope. It has been known in this Province from but one specimen taken on the Caribbean slope of the Volcan de Chiriqui, at 7,000 feet.

**Phlœoceastes melanoleucos malherbii** (Gray).—Nos. 34246–48: males and female; December 2, 4, and 9, 1931; near San Felix (100 feet). No. 34249: female; January 12, 1932; Chame (3,000 feet). A specimen in the British Museum, received from Kellett and Wood, from "Chiriqui, Veragua," appears to be the only earlier record.

**Phlœoceastes guatemalensis guatemalensis** (Hartlaub).—Nos. 32618–19: male and female; November 11, 1929; Puerto Armuelles. No. 32620: male; December 9, 1929; near Concepcion (1,500 feet). Nos. 32621, 33185: males; December 15, 1929, and February 3, 1931; Barriles (4,200 feet), El Volcan. Nos. 38507–08: male and female; January 12, 1934; Salta (5,000 feet), Boquete. More abundant and widely distributed than might have been supposed from the two specimens previously known from Divala.

**Ceophlœus lineatus nuperus** Peters.—No. 32616: female; November 9, 1929; Puerto Armuelles. No. 32617: male; December 10, 1929; near Concepcion (1,500 feet). Nos. 33182–84: female and

[2] Bull. Mus. Comp. Zool. Harvard, LXXVIII: 313, 1935.
[3] Proc. Zool. Soc. London, 1870: 211.

males; December 18, 19, and 20, 1930; El Banco (900 feet). No. 34244: female; December 8, 1931; near San Felix (100 feet). No. 34245: female; January 10, 1932; Chame (2,800 feet).

Rather unexpectedly the individuals of this series all seem to appertain to *nuperus*. The basal color of the under parts is grayish and matches quite closely the color of the Canal Zone birds. The lining of the wing is Sulphur Yellow[4], not Maize Yellow as in *mesorhynchus*. The measurements (in millimeters) yielded by this series are as follows:

| *No.* | *Sex* | *Locality* | *Culmen* | *Breadth of bill at nostril* | *Wing* | *Tail* | *Tarsus* | *Middle toe and claw* |
|---|---|---|---|---|---|---|---|---|
| 32616 | ♀ | Puerto Armuelles | 39.0 | 12.0 | 192.0 | 122.0 | 28.0 | 32.0 |
| 32617 | ♂ | Near Concepcion | 43.0 | 12.5 | 188.0 | 120.0 | 29.0 | 37.0 |
| 33183 | ♂ | El Banco | 41.0 | 11.5 | 190.0 | 115.5 | 29.0 | 35.5 |
| 33184 | ♂ | " | 40.0 | 11.5 | 184.0 | 116.0 | 27.0 | 33.5 |
| 33182 | ♀ | " | 39.0 | 11.0 | 182.0 | 122.0 | 29.5 | 35.0 |
| 34244 | ♀ | Near San Felix | 37.0 | 12.0 | 179.0 | 115.0 | 26.0 | 34.0 |
| 34245 | ♀ | Chame | 36.5 | 11.0 | 181.0 | 114.0 | 27.5 | 33.0 |

**Synallaxis brachyura nigrifumosa** Lawrence.—Nos. 32647–48: male and female; December 7 and 12, 1929; near Concepcion (1,500 feet). Griscom[5] states that this bird is known in Panama definitely only from Almirante, but the British Museum has a specimen from "Chiriqui" taken by Arcé.

**Xenops rutilus septentrionalis** Zimmer.—No. 33218: female; January 12, 1931; Barriles (4,200 feet), El Volcan. An uncommon bird, which has, however, been taken prior to this on the Volcan de Chiriqui.

**Sclerurus mexicanus pullus** Bangs.—No. 32644: male; December 14, 1929; Barriles (4,200 feet), El Volcan. Rare in the Province.

**Xiphorhynchus guttatus marginatus** Griscom.—No. 33223: male; December 23, 1930; El Banco (900 feet). No. 34262: male; December 6, 1931; near San Felix (100 feet). Known from Veraguas, but not heretofore from Chiriqui.

**Tolmomyias sulphurescens flavo-olivaceus** (Lawrence).—Nos. 34293–96: males and female; November 29, and December 2, 7, and 9, 1931; near San Felix (100 feet). Nos. 38542, 38556: female and male; January 13, 1934; Salta (5,400 feet), Boquete. In the series

[4] Capitalized names of colors are those of Ridgway's *Color Standards and Color Nomenclature*, 1912.
[5] Bull. Mus. Comp. Zool Harvard, LXXVIII: 338, 1935.

under examination it has proved impossible to find characters separating Boquete specimens from those from eastern Chiriqui. All have been assigned to this subspecies tentatively, until such time as comparative material from Costa Rica and the Canal Zone is available. In spite of the paucity of early records, this species appears to be as abundant here as in Costa Rica.

**Todirostrum sylvia schistaceiceps** Sclater.—No. 32705: male; December 3, 1929; near Concepcion (1,500 feet). Nos. 34300–02: males and female; December 3, 4, and 9, 1931; near San Felix (100 feet). Although these localities are well within the range of this subspecies, previous records for this Province are not known to me.

**Oncostoma cinereigulare cinereigulare** (Sclater).—No. 34305; female; December 7, 1931; near San Felix (100 feet). Known from this territory by but one specimen from Bugaba.

**Atalotriccus pilaris wilcoxi** Griscom.—No. 33271: male; December 24, 1930; El Banco (900 feet). No. 34303: male; December 7, 1931; near San Felix (100 feet). No. 34304: female; January 14, 1932; Chame (3,000 feet). Apparently rare in western Panama, and known from Chiriqui from but one specimen taken at David.

**Serpophaga cinerea grisea** Lawrence.—Nos. 33276–78: females and male; January 12 and 15, 1931; Barriles (4,200 feet), El Volcan. Due to its habits rather than to the scarcity of individuals, museum representatives of this species are uncommon. Two examples were taken in Boquete by W. W. Brown.

**Leptopogon superciliaris hellmayri** Griscom.—No. 33257: male; January 15, 1931; Barriles (4,500 feet), El Volcan. Rare throughout its range, but it has been recorded by Salvin from Bugaba and the Volcan de Chiriqui.

**Leptopogon amaurocephalus faustus** Bangs.—Nos. 34315–18: females and males; November 28, and December 2, 4, and 10, 1931; near San Felix (100 feet). Previously taken specimens of this species from Chiriqui Province are not known to me.

**Capsiempis flaveola semiflava** (Lawrence).—No. 32706: male; December 8, 1929; near Concepcion (1,500 feet). Nos. 34298–99: male and female; December 3, 1931; near San Felix (100 feet). This bird is not of common occurrence within its range, and so far as I am aware it has been taken only once before in Chiriqui.

**Elænia chiriquensis chiriquensis** Lawrence.—Nos. 33259-61: males; December 15, 22, and 26, 1930; El Banco (900 feet). No. 34326: male; January 9, 1932; Chame (3,000 feet). Since the type specimen was secured at David by Hicks, no representative of this form has been taken within our limits.

**Myiodynastes chrysocephalus hemichrysus** (Cabanis). — No. 38535: male; December 17, 1933; Chiquero (5,000 feet), Boquete. No. 38536: female; February 5, 1934; Horqueta (5,800 feet), Boquete. An uncommon bird.

**Myiophobus fasciatus furfurosus** (Thayer and Bangs). — No. 34309: female; January 3, 1932; Chame (3,000 feet). This flycatcher is rare within its limits, and heretofore had not been encountered in Chiriqui.

**Empidonax atriceps** Salvin.—Nos. 33306–07: males; January 2, 1931; Cerro Punto (6,000 feet). The occurrence of this rather uncommon species at so low an elevation as 6,000 feet was hardly to have been expected. Other examples secured on the Volcan de Chiriqui have been taken between 10,000 and 11,000 feet.

**Myiochanes cinereus brachytarsus** (Sclater). — No. 34312: male; January 2, 1932; Chame (3,000 feet). Salvin and Godman[6] refer to a specimen said to have been recorded by Salvin[7] from Bugaba, but in the publication cited that locality is not mentioned. The species is not otherwise known from this territory.

**Vireo carmioli** Baird.—No. 38363: male; January 24, 1933; Quiel (7,800 feet), Boquete. Already recorded from Chiriqui Province, but not commonly collected.

**Hylophilus flavipes viridiflavus** Lawrence.—No. 34372: male; December 4, 1931; near San Felix (100 feet). No. 34373: male; January 9, 1932; Chame (2,800 feet). Griscom[8] records, without locality, one specimen appertaining to this form from "eastern Chiriqui." That author finds himself unable to recognize the form *pallescens*[9], to which examples from Bugaba, Divala, David, and Concepcion have been ascribed. He has, however, apparently failed to examine the type (male), taken December 6, 1929, and a female secured on the same date, near Concepcion, and the representatives of viridiflavus, of comparable age, taken in December and January, from eastern Chiriqui.

**Cyclarhis gujanensis subflavescens** (Cabanis).—No. 33347: female; January 14, 1931; Barriles (4,200 feet), El Volcan. No. 34331: female; January 3, 1932; Chame (2,800 feet). No. 38361: male; January 26, 1933; Quiel (5,300 feet), Boquete. Not abundant in Panama.

**Helmitheros vermivorus** (Gmelin).—No. 32757: male; December 15, 1929; Barriles (4,500 feet), El Volcan. Apparently no repre-

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[6] Biol. Centr.-Amer., Aves, II: 86, 1889.
[7] Proc. Zool. Soc. London, 1870: 199.
[8] Occ. Papers, Boston Soc. Nat. Hist., VIII: 202, 1935.
[9] Proc. Biol. Soc. Wash., XL: 168, 1932.

sentative of this species has been reported prior to this time from Chiriqui Province.

**Compsothlypis pitiayuma speciosa** Ridgway.—Nos. 33379–81: male and females; January 12 and 22, 1931; Barriles (4,200 feet), El Volcan. Not abundant, and known from the type locality only in the area being considered.

**Oporornis tolmiei** (Townsend).—No. 32764: male; November 7, 1929; Puerto Armuelles. Nos. 33393–94: unsexed and male; January 21 and February 4, 1931; Barriles (4,500 feet), El Volcan. A single individual taken by Brown at Boquete and three in the British Museum from "Chiriqui" seem to be the only other specimens taken in the Province.

**Seiurus noveboracensis limnæus**[10] McCabe and Miller.—No. 32761: male; November 10, 1929; Puerto Armuelles. Specimens ascribed to *S. n. noveboracensis* have been reported previous to this time, but so far this is the only individual from Chiriqui to be identified as *limnæus*. I am indebted to Messrs. McCabe and Miller for determining the identity of this example.

**Amaurospiza concolor australis** Griscom.—Nos. 33414–15: male and female; January 4 and 8, 1931; Cerro Punto (6,000 feet). One of the rarest of the fringillids, and, until these specimens were secured, known from Chiriqui from the single specimen taken by Arcé. This bird has since been taken in Boquete[11]. In addition to the examples recorded here, others were noted at the same place, and the species was also recognized, but not collected, in Quiel (7,300 feet), Boquete, in January, 1933.

**Atlapetes gutturalis coloratus** Griscom.—No. 34427: female; January 2, 1932; Chame (3,000 feet). The type series from Cerro Flores comprise all the specimens hitherto known from this Province.

**Buarremon costaricensis** Bangs.—Nos. 32833–34: male and female; December 6 and 10, 1929; near Concepcion (1,500 feet). Individuals of this species have not been taken before in the Province.

**Thraupis palmarum atripennis** Todd.—Nos. 32867–69: male and females; November 10, 17, and 25, 1929; Puerto Armuelles. The species is new to this territory.

**Piranga flava testacea** Sclater and Salvin.—No. 33495: male; January 17, 1931; Barriles (4,200 feet), El Volcan. Only recently known from this Province from Griscom's "Mts. of Chiriqui" record.

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[10] Condor, XXXV: 196, 1933.

[11] Griscom, Bull. Mus. Comp. Zool. Harvard, LXXV: 415, 1934.

**PROCEEDINGS**

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**No. 18**

# STUDIES IN THE ANDRENIDAE OF NORTH AMERICA—I*

**(Hymenoptera)**

BY

E. GORTON LINSLEY[1]

*University of California*

There are probably few genera of bees which are more imperfectly known than the genus *Andrena*. Nearly one thousand names have been applied to the North American members of this group, yet little is known of the synonymy, distribution, or habits of the majority of the species, and only a few have been adequately described in both sexes. This is particularly true of the Pacific Coast, where the Andrena fauna is remarkably rich and still comparatively little known. It is therefore the object of the present series of articles to make known, from time to time, biological and distributional information pertaining to our American forms, and to present preliminary keys for the separation of various groups of species.

The species discussed below form a convenient but unnatural assemblage, defined primarily by characters of the female sex. The series comprises those *Andrena sensu lato*, exclusive of *Trachandrena*, *Diandrena*, and *Parandrena*, in which the females are black, with the

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[1] The writer wishes to express his sincere appreciation to Mr. P. H. Timberlake and Dr. T. D. A. Cockerell for the loan of material and encouragement in this study, to Mr. E. P. VanDuzee for the privilege of studying the species contained in the California Academy of Sciences, and to Miss Grace Sandhouse of the United States National Museum and Mr. E. T. Cresson, Jr., of the Academy of Natural Sciences of Philadelphia, for the opportunity of examining certain types in their care.

pubescence all or predominantly black. The species are confined to western North America, and, although occasionally abundant, they are poorly represented in collections. Most of the species of which the habits are known appear to be oligotropic.

The black Andrenas fall rather readily into three more or less natural but unrelated groups. The first of these includes *porterae*, *caliginosa*, and *submaura*. The females of this group may be recognized by the long, first flagellar segment of the antennae (at least as long as the three following together), angular cheeks, and short facial foveae, the males by the yellow clypeus. The second series (*nigerrima* group) is characterized by the poorly defined, non-rugulose enclosure of the propodeum and the shorter, first flagellar segment never as long as the three following together. These species are confined primarily to the Rocky Mountain region. The last series (*pertristis-blaisdelli* group) may be known by the well defined, rugulose or carinate enclosure of the propodeum (thus approaching *Trachandrena* Robertson). Apparently this group falls within *Melandrena* Perez (as defined by Hedicke[2]), a subgenus based upon the European relatives of *A. morio* Brullé.

Dr. Hedicke (*op. cit.* p. 212) has proposed *Glyphandrena* for the species related to *A. carbonaria* Linn. (Europe), but these differ in the white tibial scopae and anal fimbriae of the females.

The following keys may be useful in separating the North American black *Andrenae:*

*Females*

1. Enclosure of propodeum poorly defined, finely punctured or finely tesselate, never strongly rugulose or carinate........................2

—. Enclosure of propodeum well defined, coarsely punctured, strongly rugulose or carinate........................9

2. First flagellar segment as long as the three following together; facial foveae scarcely attaining upper margin of antennal bases; genae more or less right angled........................3

—. First flagellar segment shorter than the three following together; facial foveae attaining at least the lower margin of the antennal bases; genae broadly rounded........................5

3. Malar space nearly as long as broad, more or less subquadrate; process of labrum obtuse or truncate at apex........................4

—. Malar space very narrow, several times as broad as long; process of labrum notched at apex. 9.5–10.5 mm. Calif..............(1) *caliginosa*

4. Clypeus distinctly broader than long; process of labrum subquadrate, sides indented, apex subtruncate; smaller species. 9–10 mm. S. Calif., at fls. *Ribes*........................(2) *submaura*

—. Clypeus strongly protuberant, nearly as long as broad; process of labrum subtriangular, sides entire, apex obtuse; larger species. 12–14 mm. New Mexico to Pacific Coast, at fls. *Ribes*.......(3) *porterae*

[2] Hedicke, H., 1933, *Beiträge zur Systematik der Gattung Andrena,* Mitt. Zool. Mus. Berl., **19**:216.

5\. First flagellar segment distinctly longer than the two following together; abdomen clothed with short, fine, erect hairs ..................6

—\. First flagellar segment scarcely as long as the two following together; abdomen clothed with long, coarse, depressed hairs; process of labrum deeply emarginate; clypeus with a well defined, median smooth line. 9.5–10 mm. S. Calif., at fls. *Ceanothus*...... (4) *ceanothifloris*

6\. Facial foveae distinctly widened above the middle, narrowed below; process of labrum transverse or emarginate, not triangular ..............7

—\. Facial foveae parallel-sided, scarcely widened above; process of labrum subtriangular, the apex narrowly rounded; median line of clypeus poorly defined. 9–9.5 mm. Colo ..................(5) *hicksi*

7\. Process of labrum large, apex emarginate ..............................8

—\. Process of labrum transverse, welt-like; median line of clypeus poorly defined; abdomen very finely, sparsely, indistinctly punctured, the punctures mostly about three puncture widths apart. 9 mm. Wyo ..................................(6) *pineti*

8\. Clypeus with a distinct but irregular median smooth line; apices of wings clouded; basal one-half of first abdominal tergite impunctate. 10 mm. New Mex ..............................(7) *nigerrima*

—\. Clypeus without a median smooth line; apices of wings not clouded; basal one-half of first abdominal tergite punctured; abdomen with a slight bluish tint. 11 mm. Colo........................(8) *irana*

9\. Wings lightly infuscated to very dark blackish; clypeus with a median longitudinal impunctate line; pubescence of scutum usually short ................................................10

—\. Wings hyaline or subhyaline; clypeus more uniformly punctured, usually without a median smooth line (cf. *rubrotincta*); pubescence of scutum at least one-half as long as the pleural hairs ............13

10\. Process of labrum elongate, constricted near base; propodeum rugosopunctate, enclosure with most of the rugae longitudinal or slightly oblique; abdomen distinctly punctured ......................11

—\. Process of labrum more or less triangular, apex subtruncate; propodeum tesselate, with a few shallow punctures, basal rugae of enclosure longitudinal, apical rugae transverse; scutum dull, pubescence short, dense; abdomen finely punctured. 15–16 mm. S. Calif...........................................(9) *pertristis*

11\. Wings brownish; abdominal tergites with a very narrow impunctate apical margin................................................12

—\. Wings very dark blackish; abdominal tergites with a distinct impunctate apical margin; scutum clothed with short, very sparse hairs; enclosure of propodeum coarsely rugulose. 14–15 mm. C. Calif.......................................(10) *grundeli*

12\. Punctures of scutum separated, mostly less than one to one puncture width apart; facial foveae not attaining basal line of clypeus; pubescence of scutum about one-fourth as long as that of pleura, moderately dense; rugae of propodeum fine, mostly oblique. 10–12 mm. S. Calif. at fls. *Potentilla*............(11) *bernardina*

—\. Punctures of scutum contiguous and subcontiguous; facial foveae extending below basal line of clypeus; pubescence of scutum short, sparse; rugae of propodeum coarse, mostly longitudinal. 15 mm. Calif.......................................(12) *omninigra*

13\. Tibial scopa loosely formed of long, erect hairs.........................14

—\. Tibial scopa densely formed of compact, more or less depressed hairs.......18

14. Scutum dull and rather obscurely punctured ........................ 15
—. Scutum more or less shining, distinctly punctured ........................ 16
15. Abdominal tergites with a broad impunctate apical margin, remaining surface finely punctured, the punctures mostly separated by less than three puncture widths; process of labrum moderately constricted apically; smaller species. 10–11 mm. S. Calif. at fls. *Cryptantha* ........................ (13) ***blaisdelli***
—. Abdominal tergites with a very narrow impunctate apical margin, remaining surface very finely punctured, the punctures mostly separated by more than three puncture widths; process of labrum strongly constricted apically; larger species. 11–13 mm. Calif., Ariz., at fls. *Oenothera* ........................ (14) ***oenotherae***
16. Notal hairs moderately long, not conspicuously plumose; apical depressions of abdominal tergites finely, distinctly punctured; process of labrum narrowly truncate at apex ........................ 17
—. Notal hairs short, conspicuously plumose; apical depression of first abdominal tergite impunctate except at sides; process of labrum broadly truncate (feebly emarginate) at apex. 10–11.5 mm. S. Calif ........................ (15) ***flandersi***
17. Clypeal punctures varying from one to three puncture widths apart; facial foveae attaining basal line of clypeus; punctures of scutum mostly one to two puncture widths apart; abdominal tergites with a broad impunctate apical margin comprising, at middle, one-half of posterior depression. 12 mm. S. Calif .... (16) ***linsleyi***
—. Clypeal punctures nearly contiguous; facial foveae falling conspicuously short of basal line of clypeus; punctures of scutum mostly two or more puncture widths apart; abdominal tergites with a narrow impunctate apical margin comprising, at middle, less than one-third of posterior depression. 11 mm. S. Calif .. (17) ***rubrotincta***
18. Scutum shining, distinctly punctured ........................ 19
—. Scutum dull, more or less obscurely punctured; abdominal tergites finely, closely punctured except for a very narrow smooth apical margin; pubescence of scutum short, erect. 11–13 mm. Calif. at fls. *Phacelia* ........................ (18) ***nigra***
19. Propodeum finely granulate-punctate, enclosure finely, closely, longitudinally rugulose; abdomen black. 12 mm. S. Calif .. (19) ***deserticola***
—. Propodeum coarsely granulate-punctate, enclosure coarsely and transversely or obliquely rugulose; abdomen lightly tinted with bluish. 8.5–11 mm. Calif ........................ (20) ***vanduzeei***

*Males*

1. Clypeus yellow; first flagellar segment subequal to or longer than the two following together ........................ 2
—. Clypeus black; first flagellar segment at most a little longer than the second segment ........................ 4
2. Anterior trochanters simple, without an apical finger-like process; malar space large, nearly as long as broad, subquadrate ........................ 3
—. Anterior trochanters armed at apex with a slender, finger-like process; malar space oblong, distinctly broader than long; body black, clothed with black pubescence intermixed with whitish; wings tinted with black. 8.5–9 mm. Calif ........................ (1) ***caliginosa***

3. Facial quadrangle broader than long; body black, clothed with black pubescence intermixed with whitish; wings tinted with black. 9 mm. S. Calif. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (2) *submaura*

—. Facial quadrangle longer than broad; body brownish, clothed with long fulvous pubescence; wings tinted with yellow. 10 mm. New Mexico to Pacific Coast. . . . . . . . . . . . . . . . . . . . . . . . . . . . . (3) *porterae*

4. Enclosure of propodeum rugulose or carinate, bounded by an elevated rim; mandibles broad, distinctly notched before apex. . . . . . . . . . . . 5

—. Enclosure of propodeum finely, closely punctured, neither rugulose nor carinate, not bounded by a rim or margin; mandibles long, slender, apex slightly reflexed, simple or very feebly notched. 8.5 mm. S. Calif. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (4) *ceanothifloris*

5. Wings infuscated or blackish . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 6

—. Wings hyaline or subhyaline. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 8

6. Process of labrum deeply bilobed . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 7

—. Process of labrum subquadrate, apex broadly truncate; vertex densely clothed with long black hairs; pubescence of clypeus all black; propodeum finely reticulate, enclosure with a few distinct, well separated carinae. 12 mm. S. Calif. . . . . . . . . . . . . (9) *pertristis*

7. Pubescence of face, thorax, and legs almost completely white; larger species. 11 mm. C. Calif. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (10) *grundeli*

—. Pubescence of face, thorax, and legs predominantly black; smaller species. 9 mm. S. Calif. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (11) *bernardina*

8. Notum dull, densely hairy, surface partially obscured by the pubescence; abdomen black . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 9

—. Notum shining, rather sparsely hairy on disk, surface not obscured by the pubescence; abdomen tinted with bluish. 10 mm. Calif . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (20) *vanduzeei*

9. Abdominal tergites with a distinct impunctate apical margin; process of labrum emarginate, bilobed. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10

—. Abdominal tergites with a very narrow, inconspicuous, impunctate apical margin; process of labrum nearly entire, not bilobed. 10–11 mm. Calif. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (18) *nigra*

10. Hairs of face and propodeum black; first flagellar segment distinctly shorter than second or third. 9.5–11 mm. S. Calif. . . (13) *blaisdelli*

—. Hairs of face and propodeum predominantly white; first flagellar segment subequal in length to second or third. 10–11 mm. Calif., Ariz . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . (14) *oenotherae*

## 1. **Andrena caliginosa** Viereck

*Andrena caliginosa* Viereck, 1916, Proc. Acad. Nat. Sci. Phil., **68**:552, ♀.
*Andrena maura* Viereck, 1924, Can. Ent., **56**:31, ♂ (nec ♀), new syn.

*A. caliginosa* Viereck was first described from one specimen, a female taken at San Jose, California. In 1924, Viereck proposed the name *maura* for a male (holotype) from Santa Clara Co., California, and a female (allotype) from the mountains near Claremont, California (about four hundred miles to the south). An examination of the type specimens[3], as well as material from the type series (Pomona College collection) reveals the fact that the sexes associated by Viereck represent different species. The Viereckian female belongs to the species described below as *submaura*. The true female of this species (*caliginosa*) may be redescribed as follows:

*Female.*—Black, clothed entirely with black pubescence. *Head* with its facial quadrangle about as long as broad, and more or less uniformly clothed with long, erect hairs; antennae with first flagellar segment subequal in length to the three following together; vertex dull, finely tessellate, sparsely punctured; frons closely striate; foveae broadly rounded above, and accupying about three-fourths of ocellocular space, narrowly rounded below, and attaining basal line of antennae; clypeus polished, convex, slightly protuberant, coarsely punctured, the punctures mostly from less than one to one puncture width apart; process of labrum longer than broad, apex notched, sides slightly concave; malar space narrow, very strongly transverse, elevated portion polished. *Scutum* dullish, finely tessellate, discal punctures shallow, moderately large, mostly two or three puncture widths apart, except along margins where they are about one puncture width apart; pubescence erect, about as long as that of pleura; scutellum a little more closely and distinctly punctured than scutum; propodeum with its enclosure poorly defined, feebly shining, finely tessellate, practically nude, remaining surface moderately shining, finely reticulate, moderately densely clothed with long hairs; legs slender, tibial scopa long, but moderately compact; wings tinted with brownish, veins and stigma brown. *Abdomen* shining, finely, closely tessellate, finely sparsely, obscurely punctured; apical fimbria black. Length: approx. 9 mm., anterior wing 7.5 mm.

Material studied (in addition to the types): 2♂♂, 2♀♀, Santa Clara Co., Calif., (C. F. Baker, Pomona College Collection), 3♂♂, 1♀, Mt. Diablo, Calif., Mar. 19, 1932 (Linsley), 1♂, Berkeley, Calif., Jan. 30, (E. S. Ross), and 1♂, Griffith Park, Los Angeles, Calif., March 14, 1936 (K. Anderson).

*Andrena maura* was made by Viereck (*op. cit.* p. 20) the type of a new subgenus, *Dactylandrena*, distinguished from typical *Andrena* by the presence of a spine-like process on the anterior trochanters of the male, and by the large malar space. However, there can be little doubt that *A. porterae* and *A. submaura* are both very closely related to *maura* (=*caliginosa*), and yet neither of these possess the process on the trochanters. Also, as shown above, in the true female of *maura* (*caliginosa*) the malar space is scarcely larger than usual. Apparently the only important characters shared by the above three species are the yellow clypeus of the male and the long, first flagellar segment of the female (at least as long as the three following together), angular cheeks, and short facial foveae. This combination of characters will suffice to separate the group from other black Andrenas, but hardly from all other species of *Andrena* s. str. It therefore seems advisable to suppress the name *Dactylandrena*.

[3] The types of this species are on deposit in the United States National Museum, not in the Canadian National Collection as is stated by Viereck.

## 2. **Andrena submaura** Linsley, new species

*Andrena maura* Viereck, 1924, Can. Ent. **56**:31, ♀ (nec ♂).

*Male.*—Black, clothed with long whitish and blackish pubescence. *Head* with its facial quadrangle broader than long, pubescence of underside and vertex mostly white, remainder black; antennae dark brownish-black, first flagellar segment longer than the two following taken together, frons finely striate-reticulate; clypeus polished, convex, almost entirely yellow, sparsely, shallowly, but not finely punctured, the punctures a little smaller and closer around the margins; process of labrum reduced to a shining, transverse ridge at base; malar space well developed, nearly as long as broad, polished, with a few scattered, fine punctures, more numerous near base; mandibles elongate, slender, strongly bowed, notched before apex. *Thorax* clothed above with black and whitish hairs intermixed, pubescence of pleura black, of venter white, that of pleura a little longer than on scutum; scutum finely, closely tessellate and dull around margins, shining on disk where the punctures are moderately coarse and separated by one to several puncture widths; scutellum more closely and coarsely punctured than scutum, the punctures mostly less than one puncture width apart, disk shining; metanotum dull, finely, closely tessellate, shallowly and inconspicuously punctured, clothed with very long, black pubescence; propodeum dull, surface finely tessellate, almost impunctate, clothed at sides with long, black pubescence, enclosure scarcely defined; legs slender; wings tinted with brownish, veins and stigma brown. *Abdomen* shining, surface finely tessellate, obscurely and sparsely punctured, tergites clothed with erect, black hairs, longer on first and second segment, where they are intermixed with whitish hairs, becoming progressively shorter on following segments, sternites with a row of long, erect, pale hairs at base of segments. Length: approx. 9 mm.; anterior wing 7.5 mm.

*Female.*—Black, clothed entirely with black pubescence. *Head* with its facial quadrangle longer than broad; antennae with first flagellar segment subequal in length to the three following, together; vertex dull, closely tessellate, frons closely, longitudinally striate; foveae broadly rounded above, and occupying approximately two-thirds of ocellocular distance, narrowly rounded below, and not quite attaining the basal line of antennae; clypeus polished, protuberant, coarsely punctured, the punctures varying from less than one to more than two puncture widths apart; process of labrum much broader at base than long, apical portion subquadrate, nearly parallel-sided, apex broadly truncate; malar space well developed, only a little broader than long, highly polished, practically impunctate. *Scutum* moderately shining, surface finely tessellate, discal punctures shallow, moderately coarse, mostly from two to three puncture widths apart, those of margins coarser, mostly less than one puncture width apart, pubescence erect, a little shorter than on pleura, scutellum similarly clothed, a little more closely, coarsely punctured than scutum; metanotum dull, finely tessellate, very obscurely and sparsely punctured; propodeum with its enclosure poorly defined, dullish, finely, closely tessellate, almost nude, remaining surface moderately shining, finely reticulate, moderately densely clothed with long hairs; legs slender, tibial scopa thin and loose, the hairs of the dorsal margin longer than the width of the tibia, flocculus of posterior trochanters thin, imperfect; wings tinted with brownish, veins and stigma pale brownish. *Abdomen* shining, finely, closely tessellate, finely, sparsely, obscurely punctured; apical fimbria black. Length: approx. 10 mm., anterior wing 7.5 mm.

*Holotype:* No. 4229, Mus. Calif. Acad. Sci. Ent., male, and *allotype:* No. 4230, Mus. Calif. Acad. Sci. Ent., female, and twenty-eight paratypes (one male, the remainder females) taken at **The Gavilan, about 5 miles west of Perris, Riverside Co., Calif.,** Feb. 22, 1937 (E. G. Linsley). Additional paratypes from the same locality in the collection of the writer are as follows: eight females, March

2, 1937, and three females, March 22, 1936. Paratypes in the collection of Mr. P. H. Timberlake are: 5 females, Sandbergs, Los Angeles Co., March 31, 1933, 3 females, The Gavilan, March 31, 1933, and 11 females, one male, The Gavilan, Feb. 22, 1937. All of the specimens were taken flying about *Ribes indecorum*, from which the females were gathering pollen.

This species appears to be related to *A. caliginosa* Viereck, but may be separated in both sexes by the large, subquadrate malar space. The male may be further distinguished by the absence of the conspicuous finger-like process at the apex of the anterior trochanters, and the female by the shape of the process of the labrum, the apical portion of which is subquadrate, more or less parallel-sided, and broadly truncate.

### 3. **Andrena porterae** Cockerell

*Andrena porterae* COCKERELL, 1900, Ann. Mag. Nat. Hist., (7) **5**:401, ♀; BRUNER, 1903, Trans. Am. Ent. Soc., **29**:244, ♀; COCKERELL, 1907, Univ. Colo. Studies, **4**:244, ♀; LINSLEY, 1937, Pan-Pac. Ent., **13**:157.

*Andrena leptanthi* VIERECK and COCKERELL, 1904, Ann. Mag. Nat. Hist., (7) **14**:27, ♂; COCKERELL, 1907, Univ. Colo. Studies, **4**:246, ♂.

This species, well known in the Rocky Mountain region, occurs also on the Pacific Coast. Records from this area are as follows: *Oregon:* Blitzen Valley, Harney Co., Apr. 19, 1936 (S. G. Jewett); *California:* General Grant National Park, June 27 (P. H. Timberlake), West Walker River, Mono Co., May 7, 1937 (C. D. Michener), and Lake Tahoe, July (Linsley). The females may be readily recognized by the large malar space and strongly produced clypeus, the males by the fulvous pubescence and yellow tinted wings. Apparently the females gather pollen only from *Ribes*.

### 4. **Andrena ceanothifloris** Linsley, new species

Black, clothed with black pubescence, intermixed with brownish hairs (female), notal pubescence mostly whitish (male); enclosure of propodeum poorly defined, not bounded by a rim, surface finely, very closely punctured, neither rugose nor carinate; abdomen of female clothed with long, coarse, depressed hairs; mandibles of male long, slender, slightly reflexed at apex, simple, not bidentate.

*Female.—Head* broader than long; antennae black, first flagellar segment scarcely as long as second and third together; vertex finely punctured, sparsely clothed with erect hairs; forehead finely, closely, striate-punctate; foveae not distinctly widened above the middle, broadly rounded beneath, and extending slightly below level of basal line of clypeus; clypeus shining, very finely reticulate, shallowly, moderately densely punctured, except for a median longitudinal impunctate line, sparsely clothed with sub-erect brownish hairs; process of labrum very transverse, bilobed, sides and apex emarginate; mandibles moderately broad, lying one upon the other in repose, distinctly indented before apex. *Scutum* dull, posterior area of disk shallowly, moderately, sparsely punctured, the punctures averaging about three puncture widths apart, remaining surface very finely, sparsely punctured, clothed with moderately long hairs, which are shorter than those of pleura; scutellum shallowly, closely punctured except for a large, smooth area on each side of middle at base, surface clothed with erect hairs, which are denser than those of scutum; mesepisterna finely, closely punctured; wings lightly infuscated, stigma dark brownish; legs clothed with coarse, black hairs, tibial scopa compact, the hairs subdepressed; flocculus of posterior trochanters long, curled, densely plumose, almost perfectly formed. *Propodeum* shallowly, inconspicuously punctured, enclosure poorly defined, without a raised margin, very finely, closely punctured, neither rugulose nor carinate. *Abdomen* dull, surface minutely reticulate, very sparsely punctured, clothed with very long, coarse, depressed hairs, which are slightly shorter on the ventral surface. Length 10.3 mm., anterior wing 9 mm.

*Male.—Head* very much broader than long; antennae black, first flagellar segment distinctly shorter than second, which is subequal in length to third; face shallowly but not densely punctured; clypeus shining, black, without a median impunctate line, the punctures varying from two to six puncture widths apart, apex densely fringed with white, plumose hairs; process of labrum reduced to a polished, transverse, arcuate ridge; mandibles long, slender, slightly reflexed at tip, simple or very feebly indented before apex. *Scutum* dull, very finely reticulate, sparsely punctured, sparsely clothed with erect, whitish hairs, which are more abundant near margins of disk, but shorter than those of pleura; scutellum and metanotum finely, sparsely punctured; densely clothed with long, erect, whitish hairs; wings lightly infuscated, stigma large, brownish black; legs black, finely, sparsely punctured, femora clothed with long dense, white pubescence, tibiae and tarsi clothed with brownish hairs, which are not dense. *Propodeum* very finely punctured, enclosure poorly defined, without a raised margin, surface finely, closely punctured, neither regulose nor carinate. *Abdomen* finely reticulate; basal tergite with fine, but more or less distinct, punctures, from which arise erect, whitish hairs, remaining tergites very finely, inconspicuously punctured, sparsely clothed with fine, suberect, blackish hairs. Length 8.5 mm., anterior wing 7.75 mm.

*Holotype:* No. 4231, Mus. Calif. Acad. Sci. Ent., female, taken by the writer about **two miles north of Pine Cove, San Jacinto Mts., Calif.,** (alt. approx. 6,000 ft.), July 10, 1936, gathering pollen from *Ceanothus integerrimus; allotype:* No. 4232, Mus. Calif. Acad. Sci. Ent., male, from Tetley Park, San Bernardino Mts., Calif., May 16, 1936, collected by Mr. Charles Michener, also at flowers of *C. integerrimus*. Paratypes: nine females with the same data as holotype and one female from Tetley Park, San Bernardino Mts., May 23, 1936 (Linsley); eight females in the collection of Mr. P. H. Timberlake, and nine females in the collection of Mr. F. R. Platt, taken at the same time and place as the holotype (F. R. Platt collector); six females in the collection of the California Academy of Sciences, three from Forest Home, San Bernardino Co., Calif., June 11–12, 1928 (E. C. Van Dyke), and three from the mountains near Banning, Calif., May 29, 1928 (E. C. Van Dyke).

*A. ceanothifloris* belongs in that group of black Andrenas with the enclosure of the propodeum poorly defined, non-rugulose and non-carinate. From all of the other known species in this series (males unknown), the female differs at once in the relatively short first flagellar segment of the antenna (scarcely as long as the two following together) and the long, coarse, depressed hairs which clothe the abdomen. From the males of the other black species, *ceanothifloris* may be recognized by the long, slender, reflex mandibles which are scarcely notched at apex.

### 5. **Andrena hicksi** Cockerell

*Andrena hicksi* COCKERELL, 1925, Ann. Mag. Nat. Hist. (9) **16**:628, ♀

This species may be distinguished by the very narrow, parallel-sided facial foveae. In some examples the face is vaguely greenish, the abdomen tinted with dark blue. The type has not been seen, but examples from near Ward, Colorado, June 2–9, 1933 (H. G. and H. E. Rodeck), submitted for study by Mr. E. Lanham, are referred to this species on the basis of the original description. The type locality is Boulder, Colorado.

### 6. **Andrena pineti** Cockerell

*Andrena nigerrima pineti* COCKERELL, 1931, Am. Mus. Nov. 458:13, ♀.

*Female.*—Body black, with black pubescence. Antennae with first flagellar segment nearly as long as the three following, together; facial foveae widened above the middle, extending to basal line of clypeus; median line of clypeus scarcely evident; process of labrum transverse, welt-like. Scutum tesselate, shallowly and moderately closely punctured, the punctures mostly one to one and one-half puncture widths apart, discal pubescence shorter than pleural hairs; propodeum with a vague, median ridge, enclosure poorly defined; wings lightly infuscated, not clouded at apex. Abdomen clothed with short, erect pubescence, finely, sparsely, indistinctly punctured, punctures of second tergite mostly about three puncture widths apart. Length 9 mm.

*Andrena pineti* was first described as a subspecies of *A. nigerrima* Casad, but it differs so markedly from the latter in the form of the process of the labrum that it seems best to consider it a distinct species. It may be further separated from *nigerrima* by the uniformly infuscated wings (not clouded at apex), and by the very poorly defined, median line of the clypeus.

Material examined: holotype, Pine Bluffs, Wyoming (collection of American Museum of Natural History) and one cotype (collection of Dr. T. D. A. Cockerell).

### 7. **Andrena nigerrima** Casad

*Andrena nigerrima* CASAD, 1896, Ann. Mag. Nat. Hist. (6) **18**:83, ♀; COCKERELL, 1898, Bull. Sci. Lab. Den. Univ. **11**:48, ♀; COCKERELL, 1898, Bull. Univ. N. Mex. **1**:48, ♀; BRUNER, 1903, Trans. Am. Ent. Soc. **29**:244, ♀.

*Female.*—Body black, with black pubescence. Antennae with first flagellar segment nearly as long as the three following, together; facial foveae widened and broadly rounded above, narrowly rounded below, extending a little below antennal bases; median line of clypeus distinct but irregular; process of labrum large, basal width about three times length, apex about one-half as wide as base, shallowly but distinctly emarginate. Scutum dullish, punctures mostly less than one puncture width apart, pubescence shorter than pleural hairs, moderately dense, but not concealing surface; wings lightly infuscated, apex with a dark cloud, stigma ferrugineous. Abdomen densely clothed with short, suberect hairs, finely, densely, distinctly punctured, except first tergite, which is impunctate over basal one-half to two-thirds. Length 10 mm.

Only the type of this species has been studied (collection of United States National Museum). It may be easily recognized by the impunctate basal half of the first abdominal tergite and apically clouded wings.

### 8. **Andrena irana** Cockerell

*Andrena irana* COCKERELL, 1931, Ann. Mag. Nat. Hist. (10) **3**:392, ♀.

*Female.*—Body black, abdomen with a slight bluish tinge, pubescence black. Antennae with first flagellar segment longer than second and third together, shorter than three following together; facial foveae broad, widened above middle, extending a little below antennal bases; median line of clypeus not evident; process of labrum emarginate at apex. Scutum moderately closely, shallowly punctured, the punctures mostly about one puncture width apart; wings uniformly, lightly infuscated, apex not clouded. Abdomen shining, finely, but distinctly punctured, the punctures averaging less than three puncture widths apart. Length **11** mm.

This species is related to the preceding, but differs in the punctured basal abdominal tergite, uniformly infuscated wings, and in having the abdomen vaguely tinted with bluish. Several females have been examined, all from Boulder, Colorado, May 2 (C. H. Hicks, collector).

### 9. **Andrena pertristis** Cockerell

*Andrena pertristis* COCKERELL, 1905, Can. Ent., **37**:372, ♀.

The female of this species is very distinct by its large size, robust form, and short velvety pubescence. The following description is based on the supposed male:

*Male.*—Black, clothed with blackish pubescence, except on scutum, scutellum, and metathorax, where it is long, whitish. *Head* with its facial quadrangle broader than long; vertex and interantennal area moderately densely clothed with long, erect black hairs; antennae brownish-black, first flagellar segment distinctly longer than second; clypeus sparsely clothed with erect, black hairs, apex without a dense hair fringe, surface coarsely punctured, the punctures mostly subcontiguous, but more widely separated at middle, without a definite, impunctate median line; process of labrum broadly truncate at apex; mandibles robust, extending beyond opposite apical margin of labrum, distinctly indented before apex, tips crossing over slightly in repose. *Scutum* dull, moderately densely clothed with erect, long, whitish hairs, which are subequal in length to the black, pleural hairs, surface finely reticulate, coarsely, shallowly, but not densely punctured; scutellum and metanotum densely clothed with white hairs, which are longer and denser than those of scutum; wings infuscated, stigma reddish-brown; legs clothed with brownish and blackish hairs.

*Propodeum* finely reticulated, with a superimposed network of vague but larger reticulations in area surrounding enclosure; enclosure well defined, surrounded by an elevated rim, surface with about ten, distinct, well separated, straight, more or less longitudinal carinae. *Abdomen* shining, finely, sparsely punctured, the punctures averaging at least six puncture widths apart, surface clothed with a few, fine, obscure, suberect, black hairs. Length 11 mm., anterior wing 9 mm.

Described from a male taken in the company of a female *pertristis* at Idyllwild, San Jacinto Mts., Calif., on June 10, 1936 (Linsley). A second example, tentatively referred to this species, is in the collection of Mr. Charles Michener. It was captured in Tetley Park, San Bernardino Mts., May 16, 1936, at flowers of *Prunus demissa.*

The above male is easily distinguished from all other known males of the present group in the sculpture of the propodeum (area with about ten distinct, straight, well separated, more or less longitudinal carinae). In this character it must be similar to the female of *stictigastra* (judging from the description of the latter), but the length of that species is given as 9.5 mm., and the unknown male must be considerably smaller than that of *pertristis.*

The type specimen (female) of *pertristis* was from Los Angeles. Other California localities include: mountains near Banning, May 29 (E. C. Van Dyke), Big Pines Camp, Los Angeles Co., June 16, on *Phacelia* (Timberlake), Lone Pine Canyon, San Bernardino Co., June 16, on *Stanleya* (Timberlake) and Idyllwild, San Jacinto Mts., June 10 (Linsley).

### 10. **Andrena grundeli** Linsley, new species

Black, clothed with black pubescence intermixed with a few brownish hairs (female), or with predominantly white pubescence (male); enclosure of propodeum with coarse, irregular, mostly longitudinal or oblique carinae; wings very dark, almost black; process of labrum funnel-shaped (female), strongly bilobed (male).

*Female.—Head* broader than long; antennae dark brownish, first flagellar segment longer than second and third together; vertex closely punctured, except for a smooth, impunctate area on each side of ocellar triangle, circumantennal area closely striato-punctate, face finely, sparsely pubescent with moderately long, brownish hairs, foveae widest above middle, broadly rounded above and below, upper margin extending above posterior line of ocelli, lower margin falling short of basal line of clypeus; clypeus shining, coarsely punctured, the punctures averaging one to two widths apart, except for the median, impunctate line, which is broad, conspicuous, but not well defined, apex of clypeus fringed with brownish hairs; process of labrum polished, about as long as basal breadth, suddenly narrowed and constricted over apical two-thirds, narrowed portion very convex, not quite one-third of basal breadth; mandibles broad, distinctly notched. *Notum* opaque, very sparsely clothed with short, inconspicuous hairs, surface closely, subcontiguously punctured, the punctures mostly at least one puncture width apart; wings very dark, almost black; legs clothed with blackish and brownish hairs, scopa dark brownish black, composed of long, moderately loose hairs; flocculus of posterior trochanters sparsely and very imperfectly formed. *Propodeum* closely punctured, the punctures a little closer than those of scutum, enclosure coarsely sculptured, with irregular longitudinal, or slightly oblique carinae, margin defined by a narrow, inconspicuous raised line. *Abdomen* shining, clothed with fine, erect hairs, tergites rather coarsely punctured, except for a broad, impunctate apical margin, which is ten or more puncture widths broad, punctures on basal segment mostly one to two puncture widths apart; anal fimbria brownish black. Length 15 mm., anterior wing 13 mm.

*Male.—Head* with facial quadrangle a little broader than long; antennae, beyond first flagellar segment, brownish-black, first flagellar segment slightly longer than second; facial pubescence long, erect, white, except along margins of eyes where it is black; clypeus shining, rather closely, uniformly and moderately coarsely punctured, the punctures nearly contiguous, surface clothed with very long, white pubescence; process of labrum deeply bilobed; mandibles reaching distinctly beyond opposite margin of labrum, notched before apex, crossing over slightly in repose. *Thorax* clothed almost entirely with white pubescence; scutum and scutellum dull, closely, moderately coarsely punctured, the punctures mostly less than one puncture width apart; metanotum more densely clothed with longer hairs than scutum; legs slender, mostly clothed with whitish pubescence, intermixed with black on tibiae and tarsi; wings very dark brownish-black. *Propodeum* coarsely subcontiguously punctured, enclosure coarsely punctured, with coarse, predominantly longitudinal rugae. *Abdomen* shining, distinctly and moderately coarsely punctured, the punctures mostly one to two puncture widths apart. Length 11 mm., anterior wing 9 mm.

*Holotype:* No. 4233, Mus. Calif. Acad. Sci. Ent., female, and *allotype:* No. 4234, Mus. Calif. Acad. Sci. Ent., male, from **Nippiniwasse, near Midway, Madera Co., Calif.,** (adjacent to Mariposa-Madera county line), May 24, 1936, collected by Mr. E. S. Ross. Paratypes: one female (in collection of writer) with same data, one female from Mokelumne Hill, Calaveras Co., Calif., May 22, 1931, R. L. Usinger collector, and five females, Bass Lake, Calif., June 9, 1937, B. D. White collector (two in collection of Mr. White, remainder in collection of author).

In size, *A. grundeli* approaches *pertristis* and *omninigra* but differs from these (as well as all other known members of the group) by the dull, nearly nude scutum of the female, and the very dark nearly black wings.

### 11. **Andrena bernardina** Linsley, new species

Black, clothed mostly with blackish pubescence (female), notal pubescence whitish (male); process of labrum suddenly narrowed over apical one-half (female), deeply bilobed (male); enclosure of propodeum with fine, irregular, predominently transverse or oblique rugae; wings lightly infuscated (male), blackish (female).

*Female.—Head* broader than long; antennae dark brownish, first flagellar segment subequal in length to second and third together; vertex rather closely punctured, clothed with long, fine, erect, black and brownish hairs; foveae widest at upper three-fourths, broadly rounded above and below, upper margin barely attaining posterior line of ocelli, lower margin reaching basal line of clypeus; clypeus shining closely, but not deeply punctured, the punctures subcontiguous to two puncture widths apart, median impunctate line narrow but well defined; process of labrum a little broader at base than long, sides constricted and narrow over apical one-half, apex feebly emarginate; mandibles broad, distinctly notched. *Scutum* subopaque, distinctly punctured, the punctures contiguous or subcontiguous, surface clothed with fine, short, inconspicuous, erect hairs; scutellum similarly sculptured and clothed; metanotum very closely punctured, the punctures more or less contiguous; pleural hairs longer than those of notum; wings blackish-brown; legs clothed with brownish and blackish hairs, scopa loosely formed of long, erect hairs; flocculus of posterior trochanters thin and very imperfectly formed. *Propodeum* coarsely, contiguously punctured, enclosure with fine, irregular rugae which are mostly transverse or oblique. *Abdomen* shining, tergites distinctly punctured, except for a narrow, inconspicuous, impunctate margin two to four puncture widths broad, punctures of basal segment averaging about three puncture widths apart, surface clothed with fine, short, erect hairs; anal fimbria brownish black. Length 12 mm., anterior wing 10 mm.

*Male.—Head* with facial quadrangle a little broader than long; antennae black, first flagellar segment shorter than second; face clothed with long, moderately dense, erect, blackish and whitish hairs; clypeus shining, coarsely, closely punctured, the punctures mostly subcontiguous, apex with a dense fringe of long, white, plumose hairs; process of labrum notched at apex, bilobed; mandibles reaching a little beyond opposite margin of labrum, distinctly notched before apex, tips crossing over slightly in repose. *Scutum* and scutellum dull, moderately coarsely punctured, the punctures mostly one to two puncture widths apart, surface clothed with moderately dense, whitish pubescence, which is a little shorter than that of the pleura; metanotum more closely punctured than scutum, more densely clothed with longer white hairs; wings tinged with brownish-black; legs clothed with brownish and blackish hairs. *Propodeum* coarsely, subcontiguously punctured, enclosure moderately finely, irregularly rugulose. *Abdomen* shining, distinctly punctured, the punctures on first segment averaging about three puncture widths apart, except for a distinct, apical, impunctate margin of tergites. Length 9 mm., anterior wing 8 mm.

*Holotype:* No. 4541, Mus. Calif. Acad. Sci. Ent., female, *allotype:* No. 4542, Mus. Calif. Acad. Sci. Ent., male, and five paratypes: (four females, one male), taken by the writer in **Tetley Park, San Bernardino Mts., Calif.,** May 23, 1936, at flowers of *Pontentilla glandulosa*. Additional paratypes: one female, Tetley Park, July 7, 1935, two females from the same locality, May 23, 1936, and one male, also from the same place, taken flying over the ground, all in the collection of Mr. P. H. Timberlake.

This species is related to *omninigra* Viereck, from which it may be distinguished by the smaller size (10–12 mm. as compared to 15 mm.), more widely separated punctures of the scutum, finer and more oblique rugae of the propodeum, and shorter facial foveae, which do not attain the basal line of the clypeus. From *grundeli*, it differs in the brownish, rather than dark blackish wings, and the very narrow, impunctate apical margin of the abdominal tergites of the female, the more densely punctured mesepisterna, and the predominantly black facial pubescence of the male.

## 12. **Andrena omninigra** Viereck

*Andrena omninigra* Viereck, 1917, Trans. Am. Ent. Soc., **43**:385, ♀.

*Female.*—Black with black pubescence. Facial foveae broadened above the middle, extending a little below basal line of clypeus; process of labrum about one and one-half times as broad as long, sides concave, apex narrowly rounded. Scutum opaque, closely, contiguously and subcontiguously punctured; pubescence short, sparse; wings dark brownish; propodeum coarsely, rugoso-punctate, enclosure irregularly, both longitudinally and obliquely carinate, bounding carina indistinct. Abdomen coarsely punctured, apical margin narrow, the punctures of second tergite separated by one to two puncture widths. Length 15 mm.

The only example of this species seen by the writer is the type, in the collection of the Academy of Natural Sciences, Philadelphia. It is related to *grundeli* and *bernardina*, differing from the former in the paler wings, narrow, impunctate apical margin of tergites, and finer carinae of the propodeum. From the latter it may be distinguished by the larger size, smaller facial foveae, more closely punctate scutum, etc. (see above).

## 13. **Andrena blaisdelli** Cockerell

*Andrena blaisdelli* Cockerell, 1924, Pan-Pacific Ent., **1**:59, ♀.

Among the clear-winged species with a loosely formed tibial scopa, the female of *blaisdelli* is very distinct in the dull scutum, and broad, impunctate apical margin of the abdominal tergites (giving a constricted appearance to the segments of the abdomen). The supposed male of this species has the hair of the notum white, that of the face and propodeum black. The females gather pollen from *Cryptantha* and the species ranges from San Diego County north to Los Angeles, San Bernardino, and Riverside Counties.

## 14. **Andrena oenotherae** Timberlake

*Andrena oenotherae* Timberlake, 1937, Pan-Pacific Ent., **12**:69, ♀ ♂.

*A. oenotherae* rather closely resembles *A. blaisdelli*, but the female differs in the narrow, apical margin of the abdominal tergites, which are more finely and less closely punctured, the more shining clypeus, and the slightly larger average size. This species gathers pollen from *Oenothera*, but occasionally visits *Gilia*, *Ericameria*, *Cryptanthe*, *Salix*, *Eriogonum*, etc., and ranges from central California to southern Arizona. For a comparison of the putative males of *oenotherae* and *blaisdelli*, see Timberlake (1. c.).

### 15. **Andrena flandersi** Timberlake

*Andrena flandersi* TIMBERLAKE, 1937, Pan-Pacific Ent., **12**:72, ♀.

This species may be identified readily by the nearly punctureless, apical depression of the abdominal tergites, the shining scutum, and the short, densely plumose, scutal hairs. It occurs on the Mojave Desert, on *Ericameria*, but not collecting pollen.

### 16. **Andrena linsleyi** Timberlake

*Andrena linsleyi* TIMBERLAKE, 1937, Pan-Pacific Ent., **12**:71, ♀.

A larger and more robust species than *flandersi*, with the scutum only feebly shining. The abdomen may be tinged with reddish, and the apical half of the posterior depression of tergites two to four is smooth and impunctate. The species is found on the Colorado Desert, and has been taken at flowers of *Hyptis emoryi*, but not collecting pollen.

### 17. **Andrena rubrotincta** Linsley, new species

Black, abdominal tergites tinged with reddish; pubescence black or brownish-black; scutum distinctly shining, the punctures mostly two or more puncture widths apart; abdominal tergites with a narrow impunctate apical margin which at middle occupies less than one-third of the transverse depression, punctures on first tergite mostly three to six puncture widths apart.

*Female.—Head* with its facial quadrangle a little longer than broad; antennae black, apical half of flagellum brownish, first flagellar segment about as long as second and third together; foveae broadened and rounded above the middle, narrowed and more or less parallel-sided from middle to rounded lower margin, which falls quite short of the basal line of clypeus; clypeus moderately coarsely punctured, the punctures nearly contiguous, except for a median longitudinal smooth line, surface clothed with brownish, plumose hairs; process of labrum subtriangular, apex feebly emarginate; mandibles moderately slender, distinctly notched before apex. *Scutum* shining, finely punctured, the punctures mostly two or more puncture widths apart, surface rather densely clothed with fine, erect, brownish-black hairs, which are shorter than those of pleura; metanotum more densely punctured and pubescent than scutum; wings subhyaline, stigma dark brownish; legs clothed with coarse brownish-black hairs, scopa loosely formed of long, erect, black hairs; flocculus of posterior trochanters thin, curled, but imperfect. *Propodeum* finely granulate-punctate, enclosure defined by an elevated rim, surface finely, irregularly rugulose. *Abdomen* tinged with reddish, clothed with rather numerous, short, erect, blackish hairs; tergites with a narrow, impunctate apical margin, which at middle occupies less than one-third of posterior depression; punctures of first tergite irregularly distributed, averaging five or six puncture widths apart, those of second tergite finer, a little transverse, mostly about three puncture widths apart. Length 12 mm., anterior wing 10 mm.

*Holotype:* No. 4235, Mus. Calif. Acad. Sci. Ent., female, and one *paratype:* female, from the **Colorado Desert near Needles, California,** March 6, 1930 (Linsley).

This species is related to *A. linsleyi*, but differs from that species in the narrow, impunctate, apical margin of the abdominal tergites one to four, the shorter, facial foveae, which fall short of the basal line of clypeus, the distinctly shining and less closely punctured scutum, and the finely, sparsely punctured, first abdominal tergite.

### 18. **Andrena nigra** Provancher

*Andrena nigra* Provancher, 1896, Nat. Can., **22**:173, ♀; Bruner, 1903, Trans. Am. Ent. Soc., **29**:244, ♀; Cockerell, 1916, Pomona Journ. Ent. Zool., **7**:47, ♀.

*Andrena griseonigra* Cockerell, 1905, Can. Ent., **37**:371, ♂, new syn.

*Andrena subtristis* Cockerell, 1905, Can. Ent., **37**:372, ♀, new syn.

This species has been subject to greater confusion than any other species in the black group. Viereck at one time considered it the same as *subtristis* (cf. Cockerell, 1916, op. cit.), although he never published this opinion, but Cockerell pointed out that this was unlikely. Later, when Viereck described *A. caliginosa*, he introduced his description with the comment that it was probably synonymous with *nigra*. Shortly before his death, Mr. Viereck labelled a specimen of *A. blaisdelli* Cockerell (now in the collection of the United States National Museum) as, "*A. nigra* Provancher, Homotype, Viereck." However, a recent examination of the type (in the Provincial Museum, Quebec) by the writer, reveals the fact that *subtristis* and *nigra* are actually identical.

Much of the confusion in connection with this species resulted from the fact that it was incorrectly described. The Abbé Provancher's description follows:

"♀.—Long. .42 pce. Noire, sans aucune tache, avec pubescence noire. Le chaperon densément ponctué avec une petite ligne lisse au milieu. Les écailles alaires noires. La pubescence du thorax cachant les téguments. Ailes enfumées-roussâtres, les nervures noires. Pattes noires avec pubescence noire. Abdomen en ovale, poli, brilliant, avec pubescence noire.—Los Angeles (Coquillett)."

Actually, in this species the wings are hyaline, not smoky-reddish, and the clypeus has no median, impunctate line. However, the Provancher description was published posthumously and it is possible that had the Abbé lived a short while longer he would have re-checked with his type and corrected these errors. In any event, the only black *Andrena* in his collection (one of the two species in his series from California), and the actual specimen bearing his type label, written in his own hand, is a typical example of *A. subtristis*.

From field observations it appears that *subtristis* (*nigra*) is the female of *A. griseonigra*. The two sexes have been taken together at Laguna Beach, Calif., (Timberlake), Oakland, Calif., (Linsley), and Antioch, Calif., (E. C. Van Dyke, M. A. Cazier, and G. E. and R. M. Bohart). The female differs from other clear-winged species in the very dull and closely punctured scutum, and dense, compact, depressed tibial scopa. The male is distinct in the narrow, impunctate apical margin of the abdominal tergites and the entire process of the labrum. The species occurs throughout the coastal region of California. Examples at hand, other than those mentioned above, are: The Gavilan, Riverside Co., at fls. *Phacelia distans* (Linsley and Timberlake), San Diego (Blaisdell), Fresno Co., (Linsley), Mojave Desert (G. E. and R. M. Bohart), San Francisco (Van Dyke), Oakland (Linsley). *Andrena nigra* apparently collects pollen only from *Phacelia*, although the males are occasionally found early in the season visiting blossoms of *Salix*.

### 19. **Andrena deserticola** Timberlake

*Andrena deserticola* TIMBERLAKE, 1936, Pan-Pacific Ent., **12**:73, ♀.

In this species the scutum is shining and finely, closely punctured, and the enclosure of the propodeum finely, closely, longitudinally rugulose. It somewhat resembles *A. flandersi*, from which it may be distinguished by the long scutellar hairs and narrow punctureless apical margin of the abdominal tergites. The species occurs on the Mojave Desert and has been taken at flowers of *Baileya*, (Timberlake).

### 20. **Andrena vanduzeei** Linsley, new species

Black, abdomen tinged with bluish; pubescence predominantly black (female), notal hairs pale (male); process of labrum feebly emarginate at apex; propodeum coarsely granulate-punctate, enclosure with an elevated rim, surface coarsely, irregularly rugulose; scutum shining, punctures mostly about one puncture width apart.

*Female.—Head* with its facial quadrangle a little longer than broad; antennae black, first flagellar segment a little longer than fourth and fifth together; foveae broadly rounded above and below, widest above the middle, becoming slightly narrower toward lower margin, which does not attain basal line of clypeus; face densely clothed with long, erect, brownish and black hairs; clypeus shining, coarsely, closely, contiguously punctured; process of labrum emarginate at apex; mandibles short, not attaining opposite apical margin of clypeus, notched at apex. ***Scutum*** shining, the punctures very distinct, mostly about one puncture width apart, surface rather densely clothed with erect blackish hairs; shorter than those of pleura; scutellum similarly punctured and pubescent; metanotum more closely punctured than scutum; wings hyaline, stigma brownish black; legs clothed with black hairs, scopa dense, compact; floccus well curved and nearly perfectly formed. ***Propodeum*** coarsely granulate-punctate, enclosure with an elevated rim, surface irregularly rugulose, the rugulae predominantly transverse or oblique. ***Abdomen*** with a faint bluish lustre; tergites with a very narrow, impunctate, apical margin; segments distinctly but finely punctured, the punctures of first tergite mostly about four or five puncture widths apart; anal fimbria brownish-black. Length 11 mm., anterior wing 9 mm.

*Male.*—*Head* with facial quadrangle broader than long; antennae dark brownish, first flagellar segment a little longer than second; clypeus closely, subcontiguously punctured, apical margin with a dense fringe of white, plumose hairs; process of labrum very transverse, about one-fourth as long as broad, apex feebly emarginate. *Notum* clothed with long, whitish hairs; scutum shining, disk sparsely hairy, surface coarsely punctured, the punctures mostly about one puncture width apart; scutellum less coarsely punctured than scutum; metanotum very densely hairy; wings subhyaline, stigma brownish black. *Propodeum* coarsely granulate-punctate; enclosure with an elevated rim, surface irregularly rugulose. *Abdomen* shining, impunctate apical margin narrow; first tergite clothed with long, erect, white hairs, surface distinctly punctured, the punctures mostly three or four puncture widths apart. Length 9.5 mm., anterior wing 8 mm.

*Holotype:* No. 4543, Mus. Calif. Acad. Sci. Ent., female, from **Huntington Lake, Fresno Co., Calif.,** 7,000 ft. alt., July 4, 1919, collected by Mr. E. P. Van Duzee; *allotype*, male, (collection of Mr. P. H. Timberlake), from General Grant National Park, June 28, 1929, collected by Mr. Timberlake. Paratypes: four females in the California Academy of Sciences, from Huntington Lake, July 4–23, 1919, (E. P. Van Duzee); two females in the C. L. Fox Collection (Calif. Acad. Sci.) from Giant Forest, Tulare Co., Calif., July 16–17, 1923 (Fox); three females in the collection of the writer from Sequoia National Park, July, (Linsley); six females and three males in the Timberlake collection, from General Grant National Park, June 28, 1929 (Timberlake). Mr. Timberlake took females visiting *Gayophytum diffusum* and nesting in the ground, males at *Potentilla* and *Rhamnus*.

*A. vanduzeei* is apparently most closely related to *A. deserticola*, but is separable by the coarsely granulate-punctate propodeum with its enclosure coarsely, irregularly rugulose, the rugae mostly transverse or oblique, and the bluish tinted abdomen. The average size is smaller than in *deserticola* and the species is high sierran in distribution.

### **Andrena macrocephala** Cockerell

*Andrena macrocephala* COCKERELL, 1916, Ann. Mag. Nat. Hist., (8) **17**:278, ♂.
*Andrena peratra* COCKERELL, 1916, Pomona Journ. Ent. Zool., **7**:46, ♀, n. syn.

*A. peratra* Cockerell, which was associated by its author with *nigerrima* and other members of the black group of *Andrena*, is in reality a rubbed female of *macrocephala* Cockerell. Mr. Timberlake and the writer have examined the type which is now at the Citrus Experiment Station, Riverside, California, and have found that it agrees perfectly with typical females of *macrocephala* except that the red hair has been worn off the notum. The species is a common visitor at flowers of *Nemophila menziesii* in Los Angeles, San Bernardino, and Riverside Counties. Examples from Riverside, Calif., are very frequently parasitized by *Stylops timberlakei* Bohart, but in a series of more than one hundred specimens taken by the writer in Los Angeles County, none were thus stylopized. In the San Bernardino Mts. (6,000+ ft. alt.) there is a subspecies in which the notal pubescence of the female is pale fulvous, rather than bright reddish or brownish. This form visits *Nemophila integrifolia* in Tetley Park, (Timberlake, Michener, Linsley), and may be designated as **Andrena macrocephala tetleyi** new subspecies.

In the typical lowland form the notal pubescence of the male varies from fulvous to bright fox red. This pale form in the male was designated by Dr. Cockerell as *var. a*, and is properly considered as a variety. In Los Angeles County about one-third of the males taken by the writer were typical, about one-third of the pale variety, the others intermediate.

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**No. 19**

# NOTES ON THE BREEDING SEASONS OF THE ROCKY BEACH FAUNA OF MONTEREY BAY, CALIFORNIA*

BY

WILLIS G. HEWATT
*Associate Professor of Biology*
*Texas Christian University*

The records included in this report were compiled during a period of approximately two years from September 1931 to June 1933. The area covered by the investigation was restricted to the littoral region of Cabrillo Point, a granite promontory on the southern margin of Monterey Bay, California. For excellent laboratory facilities and other courtesies I am indebted to Doctor W. K. Fisher, Director of the Hopkins Marine Station of Stanford University.

During the course of an ecological study special attention was given to the breeding habits of the common species of intertidal animals of the region. Representatives of these species were collected at all seasons and examined in order to determine the conditions of the sex products. Many of the specimens were brought into the laboratory where attempts were made to fertilize their eggs by artificial insemination. The extrusion of ripe ova, or the fertilizability of eggs with subsequent development, were used as a criterion of breeding. Water samples were centrifuged and examined for sex products and larval forms.

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Very few records have been published on the breeding seasons of the northeastern Pacific coast fauna. Bovard and Osterud[1] report a list of organisms which yield embryological material during the summer months at Puget Sound. Visscher[2] gives a brief note concerning the seasonal attachment of larval types on test panels submerged in San Diego harbor. Coe[3] gives the reproductive seasons of a number of sessile species found at La Jolla.

Orton[4] published an account of the breeding seasons of the marine animals of the coast of England. He pointed out the correlation between the breeding seasons and sea temperatures. The records from the English coast are much more extensive than those concerning the Pacific coast fauna. No thermal correlations can be established from the small amount of data presented in the present report, since the records cover only a comparatively short period of time. It is hoped, however, that this material will form a basis for further knowledge concerning the reproductive seasons of the Pacific coast animals.

The breeding records of 52 species are given in the following list. The exact dates on which data were collected with a descriptive note concerning each species are also given. For convenience the list is arranged in alphabetical order under the separate phyla.

## ANNELIDA

*Arenicola* sp. An egg mass was found attached to the shelly bottom of a tide pool on October 21, 1931. A mass of eggs was collected from a tide pool on May 16, 1933. They were in the early cleavage stage and after seven days trochophore larvae were developed. The trochophores escaped from the gelatinous matrix after eight days. Four setae were present on each larva twelve days after the eggs were collected.

*Lumbrinereis* sp. One specimen shed eggs in the aquarium on May 17, 1933.

*Nereis* sp. Many ovigerous specimens were found under intertidal boulders on April 26, 1932. At 11 P. M. on May 31, 1932, *Heteronereis* forms of this annelid were found to be spawning.

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[1] Bovard, J. F., and Osterud, H. L. 1918. Partial List of the animals yielding embryological materials at the Puget Sound Biological Station. Publ. Puget Sound Biol. Station, **2**: 127-137.

[2] Visscher, J. Paul, 1928. Nature and extent of fouling of ships' bottoms. Bull. U. S. Bureau of Fisheries. **43**. pt. 2: 193-252.

[3] Coe, Wesley R. 1932. Season of attachment and rate of growth of sedentary Marine Organisms at the pier of the Scripps Institution of Oceanography, La Jolla, California. Bull. Scripps Inst. Oceanogr. Tech. Ser., **3**:37-86.

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## ARTHROPODA

*Betaeus harfordi* (Kingsley). Three ovigerous specimens were collected on December 7, 1931.

*Cancer jordani* Rathbun. On November 20, 1932, two ovigerous specimens were collected.

*Cirolana harfordi* (Lockington). Many specimens were ovigerous in April, 1932.

*Crangon bellimanus* (Lockington). Two ovigerous specimens were collected on July 20, 1932.

*Crangon dentipes* (Cuerin). Ovigerous specimens were collected as follows: nine, December 7, 1931; seven, May 23, 1932; two, June 2, 1932; four, July 17, 1932.

*Hapalogaster cavicauda* Stimpson. Three ovigerous specimens were taken on November 18, 1931, and five on May 17, 1932.

*Hemigrapsus oregonensis* (Dana). Two ovigerous individuals were taken on May 12, 1932.

*Lophopanopeus heathii* Rathbun. Nine ovigerous specimens were taken on April 22, 1932. Four individuals were taken on June 20, 1932.

*Ligyda occidentalis* (Dana). Egg-bearing specimens were taken on May 28, 1932 and June 17, 1933. Females carrying young (25 mm. long) were found on May 4, 1932.

*Melita* sp. Ovigerous specimens of this black amphipod were abundant under *Pelvetia* on March 17, 1932.

*Mimulus foliatus* Stimpson. Specimens carrying eggs were taken on December 8, 1931, April 22, 1932, and June 20, 1932.

*Pachycheles rudis* Stimpson. Several ovigerous specimens were taken on the following dates: December 7, 1931; May 23, 1932; June 20, 1932; July 18, 1932; February 8, 1933.

*Pachygrapsus crassipes* Randall. These crabs were found to be ovigerous during May, June, and July, 1932.

*Pagurus granosimanus* (Stimpson). Many specimens of this hermit crab were carrying eggs during April and May, 1932. A few ovigerous individuals were collected in February, 1933.

*Pagurus samuelis* (Stimpson). Ovigerous specimens of this hermit crab were also collected during April and May, 1932, and in February, 1933.

*Petrolisthes cinctipes* (Randall). Ovigerous crabs of this species were collected during all seasons of the year with the exception of the summer months. Dates on which they were taken are: December 9, 1931; April 26, 1932; May 12, 1932; October 13, 1932; February 4, 1933; March 20, 1933; and April 12, 1933.

*Pugettia producta* (Randall). Six ovigerous specimens of the kelp crab were taken on March 17, 1932.

*Pugettia richii* (Dana). Ovigerous specimens were collected on December 8, 1931, May 23, 1932, and July 17, 1932.

*Pycnogonum stearnsi* (Ives). Ten ovigerous specimens of this pycnogonid were taken on November 28, 1932.

*Spirontocaris picta* (Stimpson). These prawns were found bearing eggs in February and July, 1932.

*Synalpheus lockingtoni* Coutiere. Only one ovigerous specimen of this pistol-shrimp was found on July 21, 1932.

## MOLLUSCA

*Ischnochiton magdalenensis* (Hinds). One specimen spawned in the aquarium on June 27, 1932.

*Katharina tunicata* (Wood). One of these chitons spawned in the aquarium on May 17, 1932. Eggs of four females were fertilized and larvae developed during July of 1932.

*Mopalia muscosa* (Gould). Larvae developed from artificially inseminated eggs of six individuals of this chiton in September, 1932.

*Acanthina spirata punctulata* (Sowerby). This species migrates downward to a lower level in the littoral region during the breeding season, and congregates in relatively large groups. Eight specimens deposited egg capsules under *Pelvetia* on May 14, 1932. Two groups, of 40 and 32 individuals respectively, were found copulating and depositing capsules beneath *Pelvetia* on June 22, 1932.

*Acmaea cassis pelta* Eschscholtz. Several specimens contained ripe eggs on September 5, 1932.

*Acmaea limatula* Carpenter. One specimen discharged olive-green eggs, and another released sperm in the aquarium on September 19, 1932. Eggs were fertilized in the laboratory on January 20, 1932 and ciliated larvae developed after 17 hours.

*Acmaea scabra* (Gould). One individual laid eggs in the aquarium on September 5, 1932.

*Amphissa versicolor* Dall. The helmet-shaped egg capsules, 2 mm. in diameter, of this snail were found on *Iridaea* July 4, 1932. Some of the capsules contained from 35 to 50 veliger larvae.

*Anisodoris nobilis* (MacFarland). The egg ribbons of this dorid were found in the aquarium and in tidepools on the following dates: March 7, 1932; July 12, 1932; October 15, 1932.

*Calliostoma costatum* (Martyn). Two specimens discharged bright green egg masses in the aquarium on February 9, 1932.

*Crepidula adunca* Sowerby. Two individuals were carrying young on April 2, 1932. On August 31, 1932, two members of this species carried eggs in early cleavage stage.

*Crepidula nummaria* Gould (*C. nivea Adams*). One specimen was carrying young on June 20, 1932, and six ovigerous specimens were collected July 15, 1932.

*Haliotis cracherodii* Leach. Three ovigerous specimens were taken February 24, 1932, and three more on March 19, 1933.

*Haliotis rufescens* Swainson. Two of three specimens collected March 19, 1933, were ovigerous.

*Hipponix antiquatus* (Linnaeus). Two mature females and one mature male were collected on December 7, 1931.

*Hopkinsia rosacea* MacFarland. Egg ribbons of this nudibranch were observed in tidepools on October 19, 1931, and March 19, 1932.

*Littorina planaxis* Philippi. Great numbers of these periwinkles were copulating during the last week in March, 1932. One female discharged a mass of eggs in an aquarium April 17, 1932. Trochophores were found to be abundant in plankton samples taken May 13, 1932.

*Tegula brunnea* (Philippi). One specimen discharged green eggs in the aquarium on March 8, 1932.

*Tegula funebralis* (A. Adams). One specimen discharged eggs in an aquarium April 21, 1933.

*Thais emarginata* (Deshayes). Three of these snails deposited egg capsules in an aquarium on March 6, 1932. Many individuals were observed depositing capsules in the Mytilus beds on the following dates: March 6, 1932; April 6, 1932; June 20, 1932; March 1, 1933.

## Echinodermata

*Leptasterias aequalis* (Stimpson). Four ovigerous specimens were collected on March 21, 1932. Two females carrying young were taken May 12, 1932.

*Ophiothrix spiculata* LeConte. Four ovigerous specimens were collected December 9, 1931, and two others were taken July 13, 1932.

*Pisaster ochraceus* (Brandt). Two specimens released eggs in the aquarium on May 23, 1932.

*Strongylocentrotus purpuratus* (Stimpson). Two specimens were observed spawning in a tidepool on April 7, 1932.

## Chordata

*Amaroucium californicum* Ritter and Forsyth. Eggs in cleavage stages were found in these tunicates on May 31, 1932.

*Clinocottus analis* (Girard). Egg masses of this cottoid were observed in rock crevices on November 8, 1931 and March 19, 1932.

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No. 20

# REVIEW OF THE GENUS GASTRODES*

## (Lygaeidae, Hemiptera)

BY

ROBERT L. USINGER
*Research Assistant, Department of Entomology*
*California Academy of Sciences*

Species of the genus *Gastrodes,* although rare in collections, have been turning up in increasing numbers in recent years due primarily to the interest of forest entomologists. This has resulted in the recent excellent contributions to our knowledge of the life history and economic status of the two European species, *abietum* Bergroth and *grossipes* Degeer, by Holste (1922), Nägeli (1933), and Aitkins (1936). As there has been but little systematic work published on this group from a world standpoint during the past fifty years it seemed that a synoptic key and phylogenetic arrangement might be of value at this time. Complete synonymy and bibliography have been given by Reuter (1888), Oshanin (1906), and Van Duzee (1917) and need not be repeated here.

Appreciation is due to all of those who have so generously supplied material as listed under the various species, and especially to Mr. H. G. Barber who has kindly read over parts of the manuscript, and checked them against specimens in his own collection. A visit during the summer of 1937 to the various collections of the United States and Eastern Canada made possible the study of type and other material in the United States National Museum, the Canadian National Collection, and the Provincial Museum in Quebec.

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## Genus **Gastrodes** Westwood, 1840

Body ovate to oblong-ovate, flattened; sparsely to distinctly punctate above and beneath; appendages and venter sparsely, finely pilose. Length of head subequal or slightly longer than its width including eyes; tylus distinctly surpassing juga; bucculae prominent, forming plates on either side of the tylus, almost reaching to its apex. Eyes not touching anterior angles of pronotum; ocelli more distant from each other than from eyes. Antennae inserted directly in front of the eyes and slightly below a line drawn from middle of eyes to apex of head; as long as distance from apex of head to apex of scutellum or apex of commissure of clavus; first segment one-half or less the length of second; second, third, and fourth segments subequal, or the second slightly the longest. Rostrum slender, variable in length from middle coxae to middle of second abdominal segment; inserted in a broad furrow with arcuate or angulate sides continuous with the bucculae; second segment the longest, and fourth segment shortest.

Pronotum transverse; anterior margin more or less impressed, simulating a collar; lateral margins strongly converging anteriorly, sinuate to rectilinear, the anterior and posterior angles gently rounded; divided behind middle by a more or less distinct, transverse depression into two lobes; lateral margins slightly to distinctly lamellate especially at level of transverse depression, sometimes feebly reflexed.

Scutellum very flat; slightly broader than long, or equilateral; depressed at center of disk.

Hemelytra exceeding tip of abdomen, almost or quite concealing connexivum; claval suture depressed; lamellate basal third of costal margin of corium strongly depressed at inner margin, feebly to strongly reflexed laterally, the median furrow (emboliar fracture) of corium extending as far as margin, but curved away from the margin as it proceeds posteriorly; commissure of clavus more than half length of scutellum; membrane with four or five distinct, sinuate, longitudinal veins.

Sterna and pleura strongly punctate except for smooth mesosternum at middle, and finely granular area about the ostiolar canal; mesosternum longitudinally sulcate; metasternum less so. Posterior margin of metapleuron lamellately produced, its outer angle sometimes moderately produced, and the inner angle in the males of some species roundly produced and narrowly reflexed.

Anterior femora strongly incrassate, especially in the male; two rows of fine teeth below, the outer row sometimes obsolescent, the inner row with two median or subapical, larger teeth, these large spines either directed at right angles, obliquely, or apically with respect to the longitudinal axis of the femur. Anterior tibiae curved more strongly in the males than in the females. Middle and hind femora scarcely incrassate, with three or four very small teeth subapically below. Basal segment of posterior tarsus subequal in length to second and third segments together.

Abdominal spiracles all ventrally located. Third ventral suture almost straight and reaching lateral margin.

General coloration ochraceous to the more usual ferrugineous, or even piceo-ferrugineous to black, the head and thorax, excepting posterior lobe of pronotum, always black.

Genotype:—*Cimex abietis* Linnaeus.

The genus *Gastrodes* has led a checkered career nomenclatorially. Schilling first restricted the group under the name *Platygaster* in 1829. As this name was preoccupied in the Hymenoptera a series of names was subsequently proposed by various authors to replace it. *Gastrodes* was the first of these, proposed by Westwood in 1840 with *Cimex abietis* Linnaeus as the type. Subsequently Gistel proposed *Oimoctes* in 1848, Flor proposed the name *Ancylopus*, (1860), which was preoccupied in the Coleoptera, and Fieber proposed

*Homalodema* in 1861. These last are, of course, unnecessary if we follow the *insect* described by Westwood as *Gastrodes* (see Panzer, 1805). If, however, we follow the *name abietis* (=*erraticus* Fabricius fide Horvath, 1898), we must then call all of our *Eremocoris* (type *erraticus* Fabricius 1794) species *Gastrodes* and use the next oldest name, *Oimoctes*, for our *Gastrodes* species. Such a procedure is in accord with a strict interpretation of the opinion of the International Commission on Zoological Nomenclature which states that in such cases, "it is to be assumed that the author's determination of the species is correct." However, we know, in the present case that the author's determination is incorrect, for Westwood refers to Panzer's beautifully colored figure, which clearly represents *abietis* Auct. nec Linnaeus. Cases of this kind have been exhaustively discussed by the International Commission (see Opinion 65) with the recommendation that individual cases be submitted to the Commission for consideration. The change to *Oimoctes* would confuse all records of two of our old and well established genera of Lygaeidae. Moreover the description of the genus *Gastrodes* would not agree with any of the species included in it. The name *Gastrodes* is being used incorrectly at the present time for a group of Ctenophores.

The most reliable specific characters in this group appear to be the length of the rostrum, antennal proportions, shape of pronotum, degree that lamellate portions of pronotum and corium are reflexed, incrassation and spines of front femora, size, and general coloration.

## Key to the Species of Gastrodes[1]

1. Basal antennal segment short, one-third length of second segment, scarcely exceeding apex of head. Clavus and inner corium ochraceous except for an arcuate, fuscous fascia . . . . . . . . . . . . . . . . *abietum*

—. Basal antennal segment nearly one-half length of second, distinctly surpassing apex of head. Corium ferrugineous or darker, unicolorous . . . 2

2. Length of head subequal to width including eyes. Posterior inner angles of metapleura not produced or reflexed. Average size small, approximately 5 to 7.3 mm. in length. Males with anteapical spines of front femora directed at right angles or slightly obliquely to the main axis, not strongly bent dorsally and apically . . . . . . . 3

—. Head longer than wide including eyes. Antennae black. Posterior inner angles of metapleura in males roundly produced and distinctly reflexed. Larger species, approximately 7 to 8.5 mm. in length. Males with front femora greatly enlarged, the anteapical spines strongly bent and directed dorsally and apically . . . . . . . . . . 6

3. Lateral margins of pronotum scarcely or not at all sinuate at level of transverse impression, appearing rectilinear or even slightly arcuate. Rostrum attaining intermediate coxae, the first segment reaching about to level of middle of eyes . . . . . . . . . . . . . . . . *pacificus*

—. Lateral margins of pronotum distinctly sinuate at level of transverse impression . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4

[1] *Walleyi* n. sp. has not been included because the damaged condition of the type does not permit its exact placement. It is the only known species with an apically bifid femoral spine, and the only positively known specimen from Eastern North America.

4. Antennae black, short, equal in length to distance from apex of head to apical third of scutellum. Sides of pronotum not regularly narrowing anteriorly, the anterior lobe broader with sides subparallel at middle. Disk of pronotum entirely black except on lateral margins . . . . . . . . . . *remotus*

—. Antennae ferrugineous at least in part, at least as long as distance from apex of head to tip of scutellum. Sides of pronotum rather strongly and regularly narrowed from base to apex, its disk ferrugineous on posterior lobe . . . . . . . . . . 5

5. Antennae long, as long as distance from apex of head to apex of commissure of clavus, the first segment surpassing apex of head by more than half its length. Lamellately expanded margins of coria feebly but distinctly reflexed. Body comparatively feeble and slender . . . . . . . . . . *grossipes*

—. Antennae shorter, as long as distance from apex of head to apex of scutellum, the first segment surpassing apex of head by less than half its length. Lamellately expanded margins of coria scarcely reflexed. Body more rounded and robust . . . . . . . . . . *japonicus*

6. Rostrum distinctly surpassing posterior coxae, reaching at least to middle of first abdominal segment. Corium, venter, and base of pronotum ferrugineous . . . . . . . . . . *conicola*

—. Rostrum not or scarcely exceeding posterior coxae . . . . . . . . . . 7

7. Corium, venter, and base of pronotum piceo-ferrugineous to black. Lateral margins of pronotum rectilinear . . . . . . . . . . *arizonensis*

—. Corium, venter, and basal lobe of pronotum much paler, ferrugineous. Lateral margins or pronotum feebly sinuate at level of transverse impression . . . . . . . . . . *intermedius*

## Phylogenetic Relationships

*Abietum* was separated generically from *grossipes* by Stål (1872) as follows:

"Articulo primo antennarum apicem capitis paullo superante; femoribus anticis marium subtus antice spina valida nutante armatis; acetabulis posticis marium postice in lobum apice uncinatum ampliatis; segmento ventrali quinto feminarum postice angulatim emarginato, emarginatura basin segmenti subattingente."

Although this generic separation has not been generally accepted *abietum* is clearly an element distinct from the *grossipes-japonicus* group. Furthermore *pacificus*, due to its larger size and shorter rostrum, represents a slight departure from the "typical" *grossipes* group, and forms a transition toward the very distinct *intermedius-arizonensis-conicola* group. These last species, besides their larger size, flatter dorsal surface, longer head, and darker color have the anterior femora of the males greatly incrassate, while the spine on apical third of inner margin projects apically or very obliquely from an expanded and upturned plate, which forms a deep dorsal hollowing just within its margin. Such a striking character, although only occurring in one sex, sets these three species apart from their congeners. *Walleyi* n. sp. is an extreme form of this group. *Remotus* n. sp. is entirely separate and represents still another stock which may prove to be richly represented in the region of South China.

## Synoptic Descriptions of Species

### 1. **Gastrodes abietum** Bergroth, 1914

Body very much flattened above. Punctures fine and rather sparse. Surface, especially of head, pronotum, and scutellum, highly polished. Head slightly longer, eyes included, than broad, 22::20. Antennae equal in length to distance from apex of head to tip of scutellum, the basal segment short, one-third length of second, scarcely exceeding apex of head; proportion of segments one to four as 7½:24:20:19. Rostrum attaining posterior coxae, its basal segment reaching level of posterior margins of eyes, not attaining base of head. Pronotum with lateral margins carinate throughout their length, lamellately expanded at level of transverse impression and often slightly reflexed at this level; posterior margin shallowly but distinctly emarginate. Lamellately expanded outer margins of coria feebly reflexed only basally.

Males with anterior femora armed beneath with a strong, subapical tooth followed by a row of finer teeth to apex. Another strong tooth is located at the middle, and is bent obliquely forward and upward. It is joined to the subapical tooth by a smooth, sinuate ridge. Posterior inner angle of metapleuron produced and strongly reflexed posteriorly.

Females with only one strong, oblique, subapical spine on anterior femora. Fifth ventral segment posteriorly strongly angulately emarginate, reaching almost to base of segment.

Color much lighter than in the other described species. Lateral margins of pronotum ochraceous throughout their entire length. Antennae with first segment, except narrowly at apex, and second segment, except at base and apex, ferrugineous; otherwise black. Corium ferrugineous laterally and apically. Clavus and inner corium ochraceous, the corium with a fuscous fascia along claval margin from apex, arcuate or elbowed anteriorly to tip of emboliar suture. Membrane pale at inner, basal third with a fuscuous spot at center of pale area.

Length 5.2 to 7.4 mm. Greatest width (abdomen) 2.6 to 3 mm.

Specimens examined: Two specimens from Thame Park, Oxford, England sent by Mr. W. E. China. Also two specimens, Moldavia, and one, "Europe", in the P. R. Uhler Collection; two specimens, Thüringen, Breddin, C. F. Baker Collection; and one specimen, Germany, all in the collection of the United States National Museum.

Distribution: Norway, Sweden, Finland, England, Scotland, France, Germany, Switzerland, Austria, Hungary, Corsica, Italy, Moldavia, Caucasus, and Siberia.

Horvath (1898) examined the type of *Cimex abietis* Linnaeus (1758) and found it to be identical with *Eremocoris erraticus* Fabricius (1794). Although Reuter (1908) cast some doubt on the reliability of these "types" bearing "labels in Linné's handwriting," *Gastrodes abietis* auct., nec Linnaeus, was renamed *abietum* by Bergroth (1914). Excellent colored illustrations of this species may be seen by referring to Panzer (1805) or Nägeli (1933).

## 2. **Gastrodes grossipes** (Degeer), 1773

Body not excessively flattened, the anterior lobe of the pronotum and disks of coria distinctly elevated. Punctures fairly dense and coarse. Black portions of head and thorax glabrous, but less smooth and polished than in *abietum*. Head almost as long as wide including eyes, 20½::21. Antennae very long, equal to distance from apex of head to apex of claval commissure; first segment long, almost one-half length of second, surpassing apex of head by more than half its length; proportion of segments one to four as 11:24:23:24. Rostrum attaining posterior coxae, its first segment reaching base of head. Pronotum transverse, 45::26, with anterior lobe relatively strongly convex; lateral carinae obsolescent anteriorly, not at all reflexed, the lateral margins distinctly sinuate at level of transverse impression; posterior margin more evenly and shallowly emarginate than in *abietum*. Lamellately expanded lateral margins of coria more expanded than in *abietum*, feebly reflexed throughout their length, subparallel basally, and then feebly sinuate. Anterior femora of both sexes armed beneath with but one subapical, stout tooth. Inner posterior angle of metapleuron neither produced nor reflexed in either sex.

Females with fifth ventral segment shallowly, roundly emarginate posteriorly, scarcely reaching one-third of the distance to base of segment.

Color black on head and thorax, excepting posterior lobe of pronotum. Elsewhere ferrugineous, becoming darker on basal segment and at joints of antennae, on clavus and corium apically, and more or less on venter.

Length 5 to 7.2 mm. Greatest width (abdomen) 3.1 mm.

Specimens examined: Two specimens, Orshott and New Forest, England, from W. E. China; one specimen, Paris, France, E. P. Van Duzee Collection; four specimens, Moldavia, Montandon; two specimens, England, C. F. Baker Collection; one specimen, England, P. R. Uhler Collection; and one specimen, Hongkong, Koebele, the last eight specimens all in the United States National Museum.

Distribution: Norway, Sweden, Finland, England, Scotland, Ireland, France, Germany, Switzerland, Corsica, Hungary, Moldavia, Caucasus, Siberia, and China.

This is *Cimex ferrugineus* of Linnaeus (1767), which name is preoccupied by *Cimex ferrugineus* Scopoli (1763). Nägeli (1933) has given excellent colored figures of this species. There seems to be an excessive amount of variation as regards length of antennae and degree to which emboliar margins are reflexed in the United States National Museum series. Hence it is possible that this and the following species may run together, although typical examples differ strikingly as indicated in the descriptions and key. The Hongkong specimen is perfectly typical of *grossipes*.

## 3. **Gastrodes japonicus** (Stål), 1874

Form broader and more robust than in *grossipes*, the punctures more distinct, especially on the corium. Head slightly broader, eyes included, than long, 22½::21. Antennae equal in length to distance from apex of head to tip of scutellum, basal segment one-half length of second, distinctly surpassing apex of head; proportion of segments one to four as 10:21:21:22. Rostrum attaining posterior coxae, the first segment not quite reaching base of head. Pronotum strongly transverse, proportion of length (measured on median line) to width 29::50; lateral margins distinctly sinuate at level of transverse impression, not at all reflexed; disk quite strongly elevated, the transverse impression deep, but quite broad and ill-defined; posterior margin very shallowly emarginate. Lamellately expanded lateral margins of coria less broadly explanate than in *grossipes*, very feebly reflexed, the corial margin evenly arcuate or scarcely sinuate at middle of lateral lamellate region. Front femora with a single, strong, subapical spine beneath in both sexes. Posterior inner angle of metapleuron rounded, not reflexed in either sex.

Females with fifth abdominal segment shallowly, roundly emarginate posteriorly, the emargination reaching only half the distance to anterior margin.

Color much as in other members of the genus, the head and thorax, excepting basal lobe of pronotum, black. Elsewhere more obscurely ferrugineous than in either *grossipes* or *pacificus*, and becoming infuscated laterally on the venter. Membrane fumose; with pale areas, especially narrowly at inner basal angle.

Length 6 to 7 mm. Width (abdomen) 2.8–3.1 mm.

Specimens examined: One specimen each from the collections of Teiso Esaki, E. C. Van Dyke, Albert Koebele, and E. P. Van Duzee from Honshu and Kyushu, Japan.

Esaki (1932) gives an illustration of this species.

Distribution: Japan (Honshu and Kyushu).

## 4. **Gastrodes pacificus** (Provancher), 1889

Form much as in *grossipes*, rather than evenly rounded along the corial margins, as in *japonicus*. Surface rather flat above, slightly less punctate than in *japonicus*, particularly on disk of anterior lobe of pronotum. Head as long as broad including eyes. Antennae of moderate length, equal to distance from apex of head to a point intermediate between tip of scutellum and apex of commissure of clavus; first segment long, almost one-half length of second and exceeding apex of head by one-half its length; proportion of segments one to four as 13:25:24:25. Rostrum very short, reaching only to middle coxae, its first segment attaining level of middle of eyes. Proportion of pronotal length (on median line) to width, 32::52; disk of pronotum less strongly elevated than in *grossipes*, and the transverse impression less deep; lateral margins carinate, lamellate at level of transverse impression, not at all sinuate here, but rectilinear to slightly arcuate, not reflexed; posterior margin very shallowly emarginate. Lamellately expanded lateral margins of coria much as in *grossipes*, feebly sinuate just before level of apex of scutellum, feebly reflexed throughout their length. Anterior femora in both sexes armed with but a single, strong, subapical tooth. Posterior inner angle of metapleuron rounded, not conspicuously produced and not reflexed in either sex.

Females with fifth ventral segment rather deeply, subangulately emarginate posteriorly, reaching two-thirds of the distance to anterior margin.

Color much as in *grossipes* and quite typical of this group of species, the fourth rostral segment at tip, apical portion of third antennal segment, and fourth antennal segment in great part infuscated.

Length 5.9 to 7.27 mm. Width (abdomen) 2.39 to 3.1 mm.

Specimens examined: Provancher's type in the Provincial Museum in Quebec; three specimens, E. C. Van Dyke collection; six specimens, E. P. Van Duzee collection including three received from Provancher at the time the species was described; four specimens in the general collection of the California Academy of Sciences; eight specimens, United States National Museum; five specimens, Canadian National Collection; and five specimens in my own collection all from the Pacific slope of the Western United States. Three additional, perfectly typical specimens at the National Museum were collected at St. George, Utah, while one in the C. F. Baker collection from Ft. Collins, Colo. has a somewhat longer rostrum and may prove to be a different thing. Mr. H. G. Barber writes that he has specimens from Nevada and Nebraska, but I have not seen these. Unique specimens from such widely separated localities in the Great Basin area suggest that careful search should be made for *Gastrodes* on all of the high, isolated mountain ranges in the western United States. Such places are as truly ecological islands today as they were physical islands during Pliocene and Pleistocene times.

Distribution: British Columbia, Washington, Oregon, California, Utah and doubtfully, Colorado, Nevada, and Nebraska.

### 5. **Gastrodes remotus** Usinger, new species

Elongate with sides subparallel, the general coloration rather dark ferrugineous and the surface rather coarsely punctate. Head scarcely longer than broad including eyes, 10::9. Antennae robust, the first segment one-half the length of second, surpassing apex of head by almost half its length; proportion of segments one to four as 7:15:13:13. Rostrum extending to posterior margins of middle coxae, the first segment a little more than half the length of second, 10::18, not attaining base of head. Pronotum robust, relatively little dilated posteriorly; the sides of anterior lobe subparallel at middle, distinctly sinuate at level of transverse impression, and subrounded anteriorly; sides dilated along entire margins but not reflexed; ratio of length on median line to posterior width 21::32; the ratio of posterior width to width of base of anterior lobe 32::26; disk moderately elevated on anterior lobe, the punctures coarse and irregular, somewhat sparse at center; posterior lobe with a sublateral, smooth, longitudinal elevation just within each humeral angle. Costal margins of coria subparallel on basal three-fourths of embolia, then distinctly sinuate and posteriorly evenly arcuate, the lamellately expanded embolia distinctly reflexed. Front femora strongly incrassate, the ratio of width to length 9::24, bearing a stout and slightly obliquely directed spine just beyond middle, and a row of smaller spines, three proximad and six distad to the large one. Front tibiae moderately bent. Inner posterior angle of metapleuron neither produced nor reflexed.

Color ferrugineous, the rostrum, antennae, legs, and base of pronotum much darker, piceo-ferrugineous to piceous. The head, pronotum except for lateral margins, scutellum, and under side of thorax black.

Length 7 mm. Width (hemelytra) 2.75 mm.

*Holotype:* male, **Macao,** in the G. W. Kirkaldy collection in the United States National Museum. The label bears no indication of the country in which the insect was collected. As pointed out (in litt.) by Mr. H. G. Barber, there are three geographical localities which bear the name Macao: Portugal, China, and Brazil (Rio Grande do Norte). Judging from our knowledge of the distribution of *Gastrodes* as well as from the known sources of Kirkaldy material it seems likely that the specimen is from Macao in southern China.

This species is not closely allied to any of the known species. It has the stout, dark antennae of the *conicola* group without the modified front femora or metapleural angles.

### 6. **Gastrodes intermedius** Usinger, new species

Rather large, the sides more nearly parallel than in *arizonensis* n. sp., with the characteristic pale ferrugineous markings of *pacificus* and its allies, but with the antennae black or piceo-ferrugineous. Head slightly longer than broad, eyes included, 22::21. Antennae about equal in length to distance from apex of head to middle of commissure of clavus; the first segment exceeding apex of head by almost half its length, less than half as long as second; proportion of segments one to four as 23:52:48:50. Rostrum reaching posterior coxae, the first segment not quite reaching base of head, second attaining level of posterior margins of front coxae. Pronotum about two-thirds as long as posterior width, the lateral margins slightly sinuate at level of transverse impression; lateral margins feebly lamellate even at sides of anterior lobe, more broadly so and scarcely reflexed at level of transverse impression. Costal margins of coria sinuate just before apices of embolia, the lamellate embolia distinctly reflexed. Front legs strongly incrassate and modified as in *conicola*. Front femur two-thirds as thick as long; two rows of spines along the lower, or inner side; a very strong, long, sinuate spine on inner apical third, which is turned up dorsally and directed more or less apically; and with a few prominent teeth on the turned up margin anterior to the large spine. Inner posterior angle of metapleuron roundly produced and narrowly feebly reflexed.

Color black on head, anterior lobe of pronotum, scutellum, and most of under side of thorax. Antennae and rostrum black to piceo-ferrugineous. Elsewhere ferrugineous.

Length 7.8 mm. Width (hemelytra) 3 mm.

*Holotype:* male, and one male *paratype*, **Dog Lake, Penticton, British Columbia,** Sept. 23, 1927, Ralph Hopping collector. The holotype, No. 4263, is in the Canadian National Collection at Ottawa while Mr. G. Stuart Walley has kindly made it possible for me to retain the paratype in my own collection.

Closely allied to the following species in its strongly incrassate front legs, stout black antennae, short rostrum, pronotal proportions, and reflexed inner posterior angles of metapleura. It differs from that species, however, in the sinuate lateral pronotal margins, more strongly sinuate and less strongly posteriorly dilated costal margins of coria, smaller size, and much paler coloration.

### 7. **Gastrodes arizonensis** Usinger, new species

(Figure 1)

Oblong-oval, large in size and rather uniformly dark in color, piceo-ferrugineous. Head slightly longer than broad, eyes included, 26::23. Antennae with first segment less than one-half the length of second, surpassing apex of head by almost half its length; proportion of segments one to four as 10:23:22:21. Rostrum short, scarcely attaining level of anterior margins of hind coxae, the first segment not reaching base of head. Pronotum narrow at base, the ratio of length on median line to basal width 29::46 (29::50 in *conicola*); lateral margins rectilinear at level of transverse impression; disk moderately elevated on anterior lobe. Costal margin of corium rather evenly rounded, the lamellate, basal portion feebly but distinctly reflexed. Fore legs strongly incrassate as in *conicola*, two and one-half times as long as broad, with a very long, strong, sharp spine on inner, apical third, which is turned up dorsally and directed apically, with several prominent teeth on the turned up margin anterior to this. Inner posterior angle of metapleuron roundly produced and distinctly reflexed.

Color pitchy black on the head, antennae, rostrum, anterior lobe and posterior lobe antero-medially of pronotum, scutellum, pleura, sterna, venter, and femora apically. Tarsi appearing paler, particularly the basal segment, which is covered beneath with fulvous hairs. Elsewhere piceo-ferrugineous or lighter, ferrugineous, on lamellar expansions of pronotum and corium.

Length 8.19 mm. Width (hemelytra) 3.27 mm.

*Holotype:* male, No. 4533, Mus. Calif. Acad. Sci., Ent. type collection, collected at **Rustler's Camp, Chiricahua Mts., Arizona,** in July 1936 by Mr. E. S. Ross.

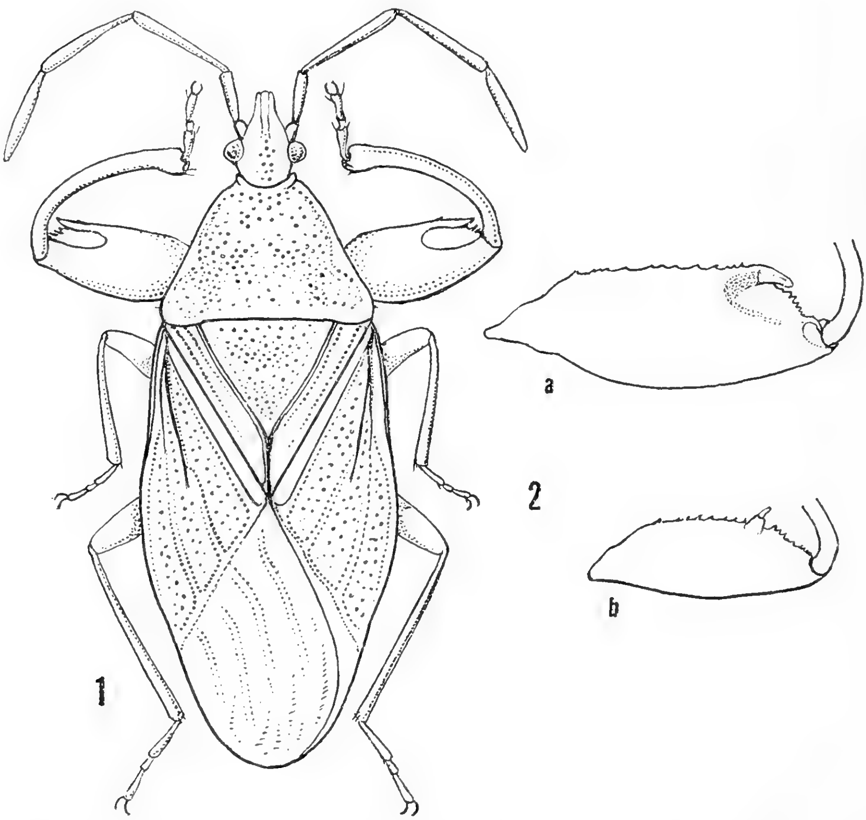


Figure 1, *Gastrodes arizonensis* Usinger, new species, male holotype. Figure 2, *Gastrodes conicola* Usinger, (a) front femur of male, (b) front femur of female.

Very near *conicola* Usinger, but with the margins of the hemelytra more arcuate, the lamellately expanded base less strongly reflexed, pronotum narrower at base, and rostrum scarcely reaching posterior coxae, its first segment attaining level of posterior margins of eyes. A pair of specimens (Cat. No. 631, Brooklyn Mus. Coll.) in the

United States National Museum from the Huachuca Mts., Arizona, are considerably smaller in size, less shining, paler in coloration, (the corium, venter, and base of pronotum ferrugineous), and have a slightly longer rostrum. Further collecting may show that these differences are constant and warrant the erection of still another species. A specimen from Nevada in the P. R. Uhler collection may belong in this group but is so mutilated as to be indeterminable.

## 8. **Gastrodes conicola** Usinger, 1933

(Figure 2)

Form more elongate, with the sides more nearly parallel than in previous species, the corium rather sparsely punctate, and the disk of anterior lobe of pronotum and of scutellum with numerous small, irregular, impunctate areas. Head distinctly longer than broad, eyes included, 30::25½. Antennae equal in length to distance from apex of head to middle of commissure of clavus, the first segment almost one-half as long as second, surpassing apex of head by one-half its length; second segment much longer than third or fourth; proportion of segments one to four as 16:34:29:28. Rostrum very long, reaching at least to middle of first abdominal segment, the first segment attaining base of head. Pronotal ratio of length on median line to width at base 29::50; disk moderately elevated, the transverse impression ill-defined but deep; lateral margins lamellate even anteriorly, feebly reflexed at middle, rectilinear to very slightly sinuate at level of transverse impression; posterior margin shallowly emarginate, rectilinear at middle. Lamellately expanded lateral margins of coria strongly reflexed basally, feebly sinuate behind this.

Males with the front femora strongly incrassate, the subapical, strong tooth of each bent dorsally and apically, and forming a cup-shaped hollowing. Posterior inner angle of metapleuron roundly produced, and distinctly reflexed.

Females with front femora less strongly incrassate, and with the subapical, strong teeth bent only slightly obliquely, as in the females of other species of the genus. Fifth ventral segment deeply, subangulately emarginate behind, reaching two-thirds of the distance to anterior margin. Inner posterior angle of metapleuron rounded, but little produced, and scarcely reflexed.

Color much as in other species, but with the antennae entirely black or piceo-ferrugineous, and the legs more or less, and the rostrum broadly at base and narrowly at apex, piceo-ferrugineous.

Length 7.3 to 8.5 mm., width 2.9 to 3.2 mm.

Specimens examined: fifty-three specimens, R. L. Usinger collection; nine specimens, Koebele collection at the California Academy of Sciences; and a series collected by Koebele and deposited in the collection of the B. P. Bishop Museum in Honolulu, all specimens from Mt. Diablo, Contra Costa County, and Cedar Mtn. Ridge, Alameda County, California, on Digger Pine, *Pinus sabiniana*. Linsley and Usinger, (1936) give a small figure of this species.

Distribution:—Mt. Diablo and Cedar Mtn. Ridge, California.

### 9. **Gastrodes walleyi** Usinger, new species

A single, much mutilated male specimen of this very distinct species is at hand. As it is the only positively known specimen of a *Gastrodes* from Eastern North America (Bank's, **1910**, record from the "Northern States" is evidently the basis for the inclusion of "*ferrugineus*" in Eastern lists), and as it exhibits characters not found in any other species, it seems best to describe it. Mr. Walley has made an effort to collect more specimens, and it is hoped that others will be on the watch for these insects in the northeastern coniferous forests where they surely occur.

Head scarcely longer than broad, eyes included. Antennae missing. Rostrum with basal segment almost attaining base of head, apex obscured. Pronotum very broad behind, less than two-thirds as long on median line as broad at base, 8::13½, the lateral margins straight or scarcely sinuate. Embolium moderately distinctly reflexed. Inner posterior angles of metapleura rounded, and very narrowly reflexed. Front legs tremendously developed, the subapical spine very stout, with two smaller, slightly divergent spines at apex, the whole process dorsally, and more or less apically directed.

Color typical of the genus, but with the pale portions brownish-ochraceous, rather than ferrugineous.

Length 8.2 mm.

*Holotype:* male, No. 4264, Canadian National Collection, **Ottawa, Ontario, Canada,** July 1, **1914**, G. Beaulieu collector.

*Walleyi* may best be referred to the *conicola* group because of the tremendously enlarged front femora and reflexed inner angles of metapleura. It differs from other species of this group in its apically bifid femoral spine, broader pronotum behind, and paler coloration.

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No. 21

# A NEW RODENT OF THE GENUS NESORYZOMYS FROM THE GALAPAGOS ISLANDS*

BY

ROBERT T. ORR
*Assistant Curator, Department of Ornithology and Mammalogy*
*California Academy of Sciences*

The native species of Galapagos rodents, as known at present, belong to two closely related oryzomine genera, *Oryzomys* and *Nesoryzomys*. To the former genus belong *Oryzomys galapagoensis* of Chatham Island and *O. bauri* of Barrington Island, although there is some question as to the valid distinction between these two forms (*cf.* Osgood, 1929; Gyldenstolpe, 1932). *Nesoryzomys* was proposed by Heller (1904, p. 241) to contain the species *indefessus* of Indefatigable and South Seymour islands and *narboroughi* of Narborough Island. It was not until 1929 that the third known species of this genus, *Nesoryzomys darwini*, was described by Osgood (*supra cit.*, p. 23) on the basis of four specimens collected that year on Indefatigable Island where only *indefessus* had previously been known to occur.

The California Academy of Sciences' Expedition to the Galapagos Islands in 1905-1906 succeeded in bringing back series of all endemic species of rodents then known to occur on these islands, with the exception of *Oryzomys galapagoensis* which, so far as known, has not been taken since Darwin's visit in 1835. These series, however, were never given critical study. It is not surprising, therefore, that in the course of carefully rechecking the identification of Galapagos

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rodents in the mammal collection of the Academy certain interesting features were brought to light. First, the presence of two examples of *Nesoryzomys darwini*, collected at Academy Bay, Indefatigable Island, on July 16 and 17, 1906, was revealed. This brings the known number of specimens of this species in collections to six. Both of these individuals, as judged by the unworn condition of the molariform teeth, are subadults closely approaching maturity.

Of equal, if not greater, interest, however, was the discovery of four unidentified specimens of the genus *Nesoryzomys* taken on James Island from which no mammals have previously been recorded. Further investigation showed that these four individuals, three old adults and one subadult, while obviously possessing generic characters ascribed to *Nesoryzomys*, were distinctly different from any of the three heretofore known species of this genus.

It is proposed that this new form be named in honor of Harry Schelwald Swarth, late Curator of the Department of Ornithology and Mammalogy, whose work has greatly added to our knowledge of the fauna of the Galapagos Islands.

## **Nesoryzomys swarthi** Orr, new species

Plate 25

*Diagnosis.*—Size large, as in *Nesoryzomys narboroughi* but in color of upper parts similar to *N. indefessus;* hairs on ventral surface of body tipped with whitish. Skull large and heavy with rostrum broad and molariform teeth large.

*Color.*—*Nesorozomys swarthi* is indistinguishable in dorsal coloration from *N. indefessus*, although the hairs of the ventral parts lack much of the yellowish tipping seen on examples of the latter species, being nearly white.

*Skull.*—Size large, with brain case proportionately long as in *N. narboroughi*, rather than short and broad as in *N. indefessus;* nasals broad with rostrum proportionately very wide; anterior palatine foramina large; palate short with anterior part of pterygoid fossa nearly on a plane with the last molariform teeth; auditory bullae larger than in either *narboroughi* or *indefessus;* molariform teeth larger than those possessed by any other members of this genus.

*Type:*—Adult male, skin and skull; No. 2556, Museum California Academy of Sciences; Mamm. Coll.; from vicinity of **Sulivan** [=Sullivan] **Bay, James Island, Galapagos Islands;** collected July 28, 1906, by J. S. Hunter.

Remarks.—While *Nesoryzomys narboroughi* and *N. indefessus* differ strikingly from each other in color (the former species being quite blackish), size of hind foot and length of tail, the cranial differences distinguishing the two species are relatively slight. *N. swarthi* resembles *indefessus* in color, but in body size, length of tail and hind foot very much resembles *narboroughi*. It thus possesses certain characters in common with each of these species. Cranially, however, it differs from either of these forms to a greater degree

TABLE I

Measurements (means and extremes) in millimeters of *Nesoryzomys*.

| | *Number averaged Sex* | *Total length* | *Tail vertebrae* | *Hind foot* | *Greatest length of skull* | *Basilar length* | *Zygomatic breadth* | *Interorbital constriction* | *Length of nasals* | *Width of nasals* | *Width of rostrum* | *Diastema* | *Alveolar length of upper molariform series* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *N. swarthi*...... | 3 ♂♂ | 312.3 (310-317) | 133.7 (124-140) | 35.7 (33-38) | 40.6 (40.5-40.8) | 31.0 (30.2-31.7) | 20.5 (20.1-20.8) | 4.9 (4.6-5.1) | 17.0 (16.2-17.5) | 4.8 (4.6-4.9) | 7.6 (7.4-7.7) | 10.6 (10.5-10.7) | 6.3 (6.2-6.3) |
| *N. narboroughi*.. | 5 ♂♂ | 280.0 (264-300) | 131.8 (127-140) | 36.4 (36-37) | 37.8 (36.8-39.6) | 28.9 (28.2-30.5) | 18.3 (17.9-19.0) | 4.7 (4.6-4.8) | 15.5 (15.1-15.9) | 4.1 (4.0-4.5) | 6.3 (6.1-6.8) | 9.6 (9.1-10.4) | 5.6 (5.4-5.9) |
| *N. indefessus*.... | 5 ♂♂ | 276.8 (260-297) | 113.6 (108-117) | 31.8 (31-32) | 37.9 (36.0-39.2) | 28.6 (26.8-29.8) | 18.8 (17.4-19.9) | 4.6 (4.3-5.0) | 16.2 (15.6-16.6) | 3.9 (3.7-4.2) | 6.6 (6.4-6.9) | 9.9 (9.3-10.3) | 5.7 (5.4-6.0) |
| *N. darwini*...... | 2 ♂♂ | 184.0 (184-184) | 85.0 (85-85) | 24.0 (23-25) | 28.9 (28.4-29.4) | 20.8 (20.2-21.4) | 14.0 (13.6-14.4) | 4.6 (4.5-4.7) | 11.8 (11.3-12.3) | 3.0 (2.9-3.1) | 4.8 (4.8-4.8) | 6.9 (6.5-7.3) | 4.8 (4.7-4.9) |

than they differ from each other, although not to the extent that they differ from *darwini*. *Swarthi* possesses broader nasals, a larger rostrum, greater diastema and much larger molariform teeth than any of the heretofore known members of this restricted genus.

As the only known examples of *Nesoryzomys swarthi* were collected over thirty years ago, and more recent expeditions to the Galapagos Islands have either overlooked or failed to collect this species, the possibility exists that this form may now be extinct as a result of the introduction of non-native, old world rats. Examples of *Rattus rattus alexandrinus* were taken during the same visit to James Island on which the specimens of *N. swarthi* were secured.

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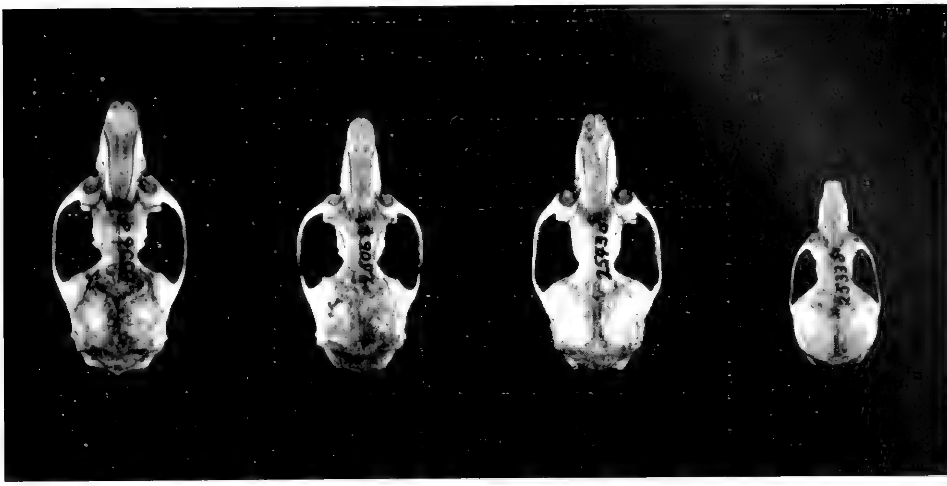
### PLATE 25

Figs. 1, 1a.—Dorsal and ventral views of the type of *Nesoryzomys swarthi* Orr, new species. No. 2556, Mus. Calif. Acad. Sci. Mamm. Coll.

Figs. 2, 2a.—Dorsal and ventral views of *Nesoryzomys narboroughi*, ♀ No. 2506, Mus. Calif. Acad. Sci. Mamm. Coll., from Narborough Island.

Figs. 3, 3a.—Dorsal and ventral views of *Nesoryzomys indefessus*, ♂ No. 2543, Mus. Calif. Acad. Sci. Mamm. Coll., from Indefatigable Island.

Figs. 4, 4a.—Dorsal and ventral views of *Nesoryzomys darwini*, ♂ No. 2533, Mus. Calif. Acad. Sci. Mamm. Coll., from Indefatigable Island.



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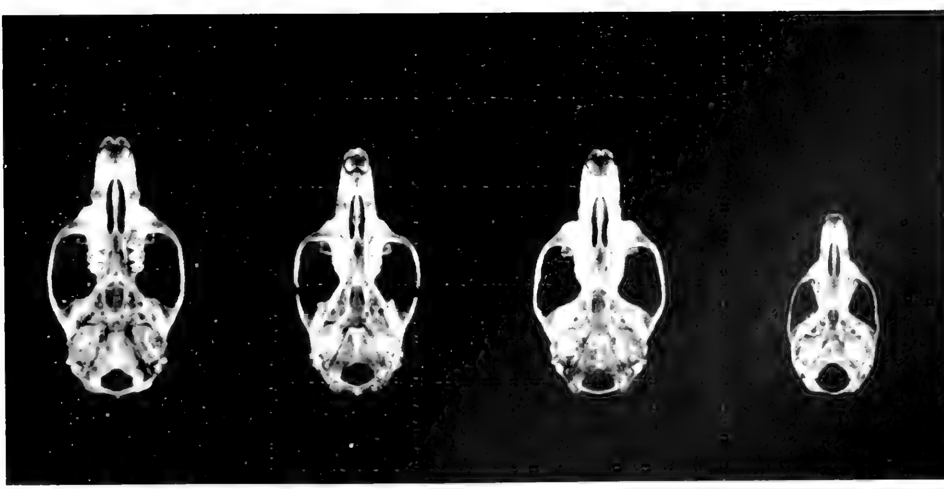

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No. 22

# MAMMALS FROM SIKANG, CHINA*

BY

ROBERT T. ORR
*Assistant Curator, Department of Ornithology
and Mammalogy,
California Academy of Sciences*

On May 27, 1936, the California Academy of Sciences received as a gift from Mr. Jack Theodore Young a collection of large mammals from near Tatsienlu, Sikang (formerly western Szechwan), far western China. The relative scarcity of material of this sort in American institutions as well as the actual rarity of certain of the species represented appear to be sufficient justification for the present paper making known the existence of these specimens. Sincere thanks are due Mr. F. E. Booth of San Francisco who paid the cost of transportation of these mammals from interior China. Each skin is accompanied by a skull and the lower limb bones.

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**Pithecus thibetanus** (Milne-Edwards), Short-tailed macacque

An adult individual of this species was secured at Tienwan, 50 miles SEE of Tatsienlu, at an altitude of 5,000 feet.

**Muntiacus muntjak vaginalis** (Boddaert), Indian muntjak

A specimen from Tienwan, 5,000 feet altitude, 50 miles SEE of Tatsienlu, proved to be the Indian species rather than the common form found in southwestern China, *Muntiacus reevesi*. It agrees with the former in large size, in the possession of small lachrymal pits which do not occupy more than the ventral two-thirds of the lachrymal bones, and in the fact that the premaxillaries contact the nasals above instead of being separated from them by forwardly projecting strips of the maxillaries. It is provisionally referred here to the race *vaginalis*, whose description it fits rather closely.

Allen (1930*b* p. 12) questioned whether *Muntiacus lachrymans* (now considered synonymous with *Muntiacus reevesi*) as described by Milne-Edwards (1871, p. 93) from Moupin, central Szechwan, actually came from the higher altitudes of Szechwan, believing it "likely that his [Milne-Edwards'] specimen came from somewhere in the upper Yangtze Valley . . . ." The specimen here recorded was taken not much over one hundred miles from Moupin, although not at a very high altitude, and represents a northern extension of the range of *Muntiacus muntjak* from southern Yunnan into west-central Sikang. Osgood (1932, p. 332), in describing *Muntiacus rooseveltorum*, characterizes that species primarily by the great development of the mental glands on either side of the jaw. The above mentioned specimen shows some tendency toward this in that the mental glands are fairly well developed, measuring approximately 22 mm. by 11 mm.

The cranial measurements of this individual, a young male with the last upper and lower molars not as yet completely grown, are as follows: condylobasal length, 194 mm.; basilar length, 180 mm.; zygomatic breadth, 81.7 mm.; alveolar length of molariform series, 60.5 mm.

**Elaphodus cephalophus cephalophus** Milne-Edwards, Tufted deer

A single specimen representing this race was taken at Gego Lake, 10,000 feet altitude, 60 miles SEE of Tatsienlu on November 19, 1935. It is an adult male in fresh pelage and appears to be closer to this form than to *Elaphodus c. ichangensis* which occurs to the east and north.

### **Pseudois nayaur szechuanensis** Rothschild, Bharal

An adult male was secured from Minya Konka, 45 miles south of Tatsienlu, at an altitude of 15,000 feet. This specimen agrees most closely with this race as described by Rothschild (1922, p. 231), and later by Howell (1928, p. 118) under the name *caesia*. There is no well-defined black area on the face, although there is a dark brown strip on the nose extending halfway back to the interorbital area. A considerable brownish tinge is present on the pelage of the back and sides. In one respect this individual shows a definite tendency toward *nayaur* which occurs to the westward in Tibet and Nepal. This is indicated in the continuity of the lateral stripe and the stripe on the hind leg, a fact which Osgood (1932, p. 336) likewise comments upon regarding specimens from near Tatsienlu. In horn structure, however, it agrees closely with *szechuanensis*.

The skull measures as follows: greatest length, 257 mm.; greatest width, 139.7 mm.; circumference of horns at base, 278 mm.; length of horns, 515 mm.; distance between tips of horns, 745 mm.

### **Capricornis sumatraensis milne-edwardsi** David, Serow

A single adult male was taken on March 24, 1936 at Tienwan, 50 miles SEE of Tatsienlu at an altitude of 5,000 feet. The pelage of this individual agrees in color with that of the race *milne-edwardsi* as characterized by Allen (1930*a*, p. 5). There is a tan area on either side of the muzzle. The hind legs and lower front legs, likewise possess considerable tan coloration. The mane is relatively dark with only a few black-tipped, white hairs present, while the body itself is quite black.

### **Naemorhedus goral griseus** (Milne-Edwards), Goral

One specimen was collected by Young at Gego, 6,000 feet altitude, 55 miles SEE of Tatsienlu. Judging from comments made by Allen (1930*a*, pp. 7–8) and others the differences between *Naemorhedus goral griseus* and *N. g. caudatus* are very slight. No other skins representing either race were available for comparison. The locality at which this individual was taken, however, is well within the range ascribed to *griseus*. The body, likewise, is relatively dark and the base of the tail brown, these at least being average characters supposedly possessed by members of this race.

**Budorcas taxicolor tibetanus** Milne-Edwards, Takin

The takin is one of the rarer game animals of this portion of China. It is therefore of considerable interest to quote Mr. Young, who in a letter of August 13, 1936, makes the following statement: "It may be very interesting to add that the Takin is supposed to be very rare and only few sportsmen had bagged them before. However, we saw over 150 heads in less than two weeks. . . ." One of the several specimens secured is now in the collection of the California Academy of Sciences. This is an adult male taken on January 15, 1936, near Gego Lake, 60 miles SEE of Tatsienlu, at an altitude of 12,000 feet.

In color it is relatively dark, even for this race. The muzzle is quite black, also the eye rings and ears. The remainder of the head and neck is golden in color. The rest of the body, however, from the shoulders back, is quite dark.

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**No. 23**

# STUDIES ON THE CLADOCERA OF MONTEREY BAY*

BY

HARRIET MARGUERITE BAKER

*Hopkins Marine Station,*

*Pacific Grove, California*

This report developed in connection with the Hydro-biological Survey of Monterey Bay, in an attempt to obtain a more satisfactory understanding and identification of the marine Cladocera of the west coast of North America.

Most of the papers in the past have been concerned with cladoceran material from very limited localities. In too many cases the examinations have been comparatively superficial and the descriptions insufficiently detailed to permit a satisfactory critical analysis of species. As a consequence, in considering problems such as that of world-wide distribution, much needed evidence has been lacking.

In the present work, in order to help clarify the situation, gleanings from the established literature of the field have been sifted and weighed; and material, comprising both live and preserved specimens (including original Lilljeborg and Tullberg materials) from widely separated sources, has been submitted to more exacting and detailed morphological analyses than previously practiced in this group.

The findings tend to indicate that marine Cladocera actually are cosmopolitan in nature. In several, widely scattered localities

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geographical races do not appear to have become clearly differentiated.

Preparation of this paper would not have been possible without the helpful coöperation of numerous people and various institutions. The primary material from Monterey Bay, and from a number of stations in the open ocean along the California coast, was furnished through the courtesy of those in charge of the Hydrobiological Survey of the Bay, and by members of the California Fish and Game Commission.

For contribution and loan of cladoceran material, deep appreciation is extended to the directors of various museums and laboratories including the Conservator, Zoologiska Institution, Uppsala University, Sweden; the Plymouth Laboratory, England; the Atlantic Biological Station, St. Andrews, New Brunswick, Canada; the Pacific Scientific Institute of Fisheries, Vladivostok, Siberia; the Marine Station, Millport, Scotland; the Naples Zoological Station; and the Copenhagen Museum, Copenhagen, Denmark.

Especially are acknowledgments due to Dr. Tage Skogsberg, at whose suggestion the work was undertaken; to Dr. W. K. Fisher, Director of the Hopkins Marine Station of Stanford University; and to others, who made it possible to carry out the work. Sincere appreciation is acknowledged for the helpful criticism from Drs. A. M. Banta of Brown University and Walter Rammner of Leipsic, Germany. So many kindnesses have been extended that the writer must content herself with this general acknowledgment.

## Material and Methods

*Material:* The primary material for this report was taken principally from surface hauls made in the southern end of Monterey Bay, California, Elkhorn Slough (an estuary of this bay), and neighboring offshore waters. Monterey Bay is about 20 miles in width, with the innermost shore line about 10 miles from its outer limit. The Bay lies between 36° 36′ and 36° 56′ N. Lat., and 121° 47′ and 121° 59′ W. Long., approximately 175 miles north of Point Concepcion, which is considered the dividing point between the northern and southern marine fauna and flora of California.

The Cladocera of Monterey Bay are not endemic, due to the fact that the Bay is in a state of continual hydrographic fluctuation.

Additional material was obtained from the following regions: —West and East coasts of Sweden, in vicinity of Skelderviken, 56° 15′ N. Lat., in vicinity of Dalarö, 59° 10′ N. Lat., and Örnskölksvik, 63° 15′ N. Lat.; —off coast of Bergen, Norway, Nos. 2716, 2747, and 2750 of Lilljeborg collection; No. 2761, T. Tullberg collection, (Uppsala University). —Off coast of Plymouth, England; —Firth of

Clyde, S. W. Scotland; —Bay of Naples; —Frenchmans Bay, Maine; —Salisbury Cove, Maine; —Peter-the-Great Bay, Japan Sea; —and off coast of southern California, 31° 31′ N. Lat., 119° 57′ W. Long.; 32° 10′ N. Lat., 122° 05′ W. Long.; 32° 55′ N. Lat., 122° 00′ W. Long.; 33° 10′ N. Lat., 119° 30′ W. Long.; 34° 35′ N. Lat., 119° 28′ W. Long.

*Methods and Measurements:* Both live and preserved specimens were examined. Most of the preserved material was treated with formalin or alcohol. Many hundred individuals of *Podon* and *Evadne* were measured and dissected and many disarticulated and dissected parts were mounted singly in glycerin jelly. For careful examination of certain deeply set morphological structures attempts at dissolution of muscles proved disappointing and unsatisfactory, regardless of method, due to fragility of tissues and integument. The extremely delicate parts, those most often sought by this process, were those which were most easily destroyed or distorted. Various selective stains proved more efficacious in making fine discriminations.

The method used in taking measurements is illustrated in Pl. 26, fig. 6, and Pl. 28, fig. 1. By and large, the two lengths used in this investigation, viz., morphological, and gross length, proved remarkably consistent when made on well preserved specimens or relaxed live ones.

An idea of the striking change in the outline of the female cladoceran following emergence of the young from the brood chamber, and the resultant change in measurement, may be deduced from the outline drawings of Pl. 26, figs. 6, 7; Pl. 28, figs. 1, 2; Pl. 29, figs. 6, 7; Pl. 31, figs. 7, 8. These changes have been for the most part ignored in earlier investigations and have led to confusion.

In attempting to establish lines for the measuring of the marine Cladocera, various problems have been encountered. Some difficulties are the many obliquities and curvatures of surfaces, the unusual angle at which the brood pouch is set, the varied positions of the eye in the preserved material and the changeableness in angle of inclination of the head in *Podon*, and the possible distortion of body outline through muscular contraction.

Some workers have used as a point of reference the angle of depression between the body and the head. This would be satisfactory, were it not for the fact that this sinus does not occur in all the genera, and that muscle contraction may to a certain degree cause distortion. The postmargin of the antenna is not an ideal point, since a new focus is often necessary to obtain the outline of the body; this change of focus would naturally modify results. The center of the nuchal organ could be used advantageously in the genus *Evadne*, but not effectively in the genus *Podon*, due to the changes resulting from the movement of the head.

The posterior point of reference needs to be defined and delimited. In a recent letter Rammner defined the basic measurements used in his work (Rammner, 1931; 618) as follows: "Als Fixpunkt für die Länge dient die Ansatzstelle der Schwanzborsten; von dort geht die Länge bis zum vordersten Punkt des Kopfes." It would make an appreciable difference whether one took the base of the caudal prominence on which the "Schwanzborsten" are attached, or the place of the attachment of the bristles in making these measurements. This would have little effect on measurements in the strictly marine *Evadne* and in some of the marine *Podon*, but if these measurements were applied to the various species of the Polyphemidae, i. e., some of outstanding forms from the Caspian Sea, the *Podon leuckarti*, and *Polyphemus pediculus*, the difference in measurement would be striking, as the distance varies markedly between the two points. If the "Ansatzstelle" were used, the measurement would include in a certain sense the measurement of the caudal section *per se* in all its varieties.

In order to obtain the proportions between the various parts it appears that statistical methods including measurements from figures on graph paper, as have been used by various workers on the fresh water forms (Woltereck, 1924; Wagler, 1927; Rammner, 1927a; and others), would yield the best results in so far as the marine forms are concerned.

*Descriptions and Plates:* To secure uniformity in the descriptions a more or less consistent terminology, applicable to the entire class Crustacea, has been employed. Only limited diagnoses have been included in this report, due to a number of generally unsettled points of the cladoceran classification, to the incompleteness of data in the literature, and to the small number of species at hand. Some of the more definitely family or generic characters are quite evidently included in descriptions along with specific ones. Thus it is reserved to future investigators to complete the diagnoses after a comprehensive study of remaining species has been made.

Unless otherwise designated in the explanation of plates, the drawings are of females. Merely outstandingly characteristic features of the males are mentioned in the descriptions.

Comparatively few spines are shown in the drawings, since there is general similarity of size and arrangement of the spines on the various joints.

## Distribution of Marine Cladocera

Even though a number of investigators have treated the distribution of the marine Cladocera (Hansen, 1899; 1–14; Schweiger, 1912: 1–21; Kajdiž, 1912: 915–40; Gibitz, 1922: 85–105; Redeke, 1922: 330–34; Rammner, 1931: 618–33; and others), none of them has attempted to approach a comprehensive treatment in regard to the occurrence of the several species discussed in this paper. For this reason, it seemed desirable to make a more thorough study of the species which have been found in California coastal waters, in order to establish whether or not these show definite correlation with environmental factors in their distribution.

There appears to be strong evidence of zonal distribution. Some forms, such as *E. tergestina*, are more or less limited to equatorial regions; other forms to cooler northern and southern waters. The latter forms at least simulate the distributional characteristics of the phenomenon of biopolarity. Whether these forms of the southern hemisphere actually are fully identical with the northern ones can not be finally established as yet, due to incompleteness of data. Scarcity of the Cladocera in the tropical regions, of course, may be apparent only, for they may occur, as does the copepod *Calanus finmarchicus*, in the deeper strata of the tropical seas, which have been altogether too insufficiently analyzed for Cladocera up to the present time. However, possible occurrence here appears fairly improbable, considering the fact that the marine Cladocera are quite bound to the superficial waters (upper hundred meters) according to my findings as well as those of others, e. g., notably Schweiger (1912: 1–21) and Kajdiž (1912: 915).

In the northern hemisphere *Podon polyphemoides* occurs in the Barents Sea and off the Murman coasts. It is also found off various European coasts, and in gulfs, and bays of these; on the east coast of North America, from Newfoundland to the southern shores of the New England States; in a similar latitude on the west coast of North America, from southern California coasts to British Columbia; and on the east coast of Asia, in Peter-the-Great Bay. Consistent with records from the northern regions are the few available ones from the southern hemisphere where this species is found on the west central to south coasts of Africa and off New Zealand.

The reports for this species are strongly suggestive that it is carried by currents from the colder regions to warmer ones, e. g., by the Labrador Current on the east coast of North America and by the Japanese Current on the west, as well as by currents from the colder, coastal waters of Africa to the equatorial regions of the west central section of this continent. However, it may be noted that this species appears to be almost entirely absent from regions from about 40° N. Lat. to 20° S. Lat. The most remarkable exceptions to this general prevalence in the cold waters are its appearance in the Bay of Guinea, in the Black Sea, and in the Mediterranean.

This species appears to be predominantly a coastal form, quite in contrast to some of the other species. Furthermore, in accordance with the present records it appears to be moderately eurythermal.

This species must be classed as somewhat euryhaline, as may be verified under the heading "Salinity," following the descriptions. For example, it occurs in the highly saline water of the Mediterranean, as well as in the nearly fresh water of the northern end of the Gulf of Bothnia.

*Evadne tergestina* appears to be the most prevalent species in the Torrid Zone, and where conditions are mild, it extends into the Temperate Zones. Except for its occurrence in the Mediterranean, and on the western coast of North America off British Columbia, it has been recorded entirely within forty degrees of the equator, and most abundantly in the equatorial regions of the different oceans. Outside of the Torrid Zone, it has been found almost exclusively in the warmer currents. Its reported appearance off British Columbia may be due to the influence of warmer waters in this region; yet this must be verified by further investigations.

*E. tergestina* has been found in the open ocean slightly less frequently than along the coast. From the existing records this species may be considered primarily a warm water stenothermal form. According to the salinites as recorded under the topic "Salinity," following the description of this species, this cladocer may be said to be moderately stenohaline.

The localities from which *Evadne nordmanni* has been reported, present a most striking parallelism to those of *Podon polyphemoides*. With the exception of the Black Sea regions all the areas mentioned for the latter species are applicable to *E. nordmanni*, even to the extremely cold sections of the Barents Sea and Murman coast, and to the contrastingly hot, equatorial regions off the west coast of Africa. *E. nordmanni* is particularly more prevalent off the coast of the British Isles, Faeröe Islands and on westward toward Iceland and Greenland. Additional regions for this later species are the coasts of Japan and on the Arctic Circle off the Alaskan coast.

Not only has *E. nordmanni* been found to thrive in coastal regions, but also as a pelagic form at great distances from the coasts. It apparently flourishes best in the colder parts of the Temperate Zones, and may be conceded to be moderately eurythermal and euryhaline. Consistent with this is the fact that this species (as also *Podon polyphemoides*), under laboratory conditions, appeared to be more or less tolerant of sudden and complete changes from sea water to distilled water.

*Evadne spinifera* has been found less commonly in the Torrid Zone than in the warmer sections of the Temperate Zones. It has been recorded least frequently in very cold waters, e. g., in the Arctic Zone off the Murman coast. It is quite common on the European coasts, and in the warmer currents of the southern part of the North Atlantic. It is also found off the southern shores of New England. In the southern hemisphere it has been recorded from the Brazil Current, on the equatorial sector of the west coast of Africa, as well as in the more southern, colder waters; also in about the same latitude in the Indian Ocean, and on the southeast and southwest coasts of Australia. In the Pacific it is again found in the northern hemisphere in Peter-the-Great Bay of the Japan Sea, and off the south and east coasts of Japan, and off the west coast of North America in southern California waters. *E. spinifera* appears to be found as commonly if not more often as a pelagic form than as a coastal form.

From the above and as verified to a certain extent under the topic "Salinity," following the descriptions, this species is to be found practically exclusively as a stenohaline form, unless the record of Marapob (1928: 205) can be verified. Furthermore, this species may be considered as moderately stenothermal.

As for seasonal occurrence of the four forms discussed, it should be said that difficulty is encountered when one attempts to give a true picture of the occurrence of the different species as they appear in the different respective localities, year after year, as it has been impossible for many of the various investigators to work continuously throughout the years with sufficiently frequent samples.

According to the observations made on the plankton samples from Monterey Bay, for the three year period, 1929–1931, the two species *Podon polyphemoides* and *Evadne nordmanni* appeared in greatest numbers early in May, and *P. polyphemoides* in the latter part of that same month. This might indicate a similar optimum of environmental factors for both species. This coincidence in regard to the optima of these two species in Monterey Bay appears to be particularly significant when general distribution is considered.

That temperature is one of the more potent factors governing the variation and distribution of the Cladocera appears rather unmistakable. This has been confirmed by numerous workers (Ward and Whipple, 1918: 748; Huntsman and Sparks, 1924: 95, 113; Brown, 1929: 262, 443, 451).

As a result of experiments on Cladocera, Brown (1929: 257) says, "Different animals of the same genus and even of the same species may differ in response to low temperature." At the same time it is maintained that physiological differences are likewise manifested by members of the same genus, as also by individuals of the same species (Obreshkove and Banta, 1930: 7–8). If there is any likelihood of a correlation between these facts, as appears quite possible (Banta and Wood, 1928a: 397–8), this might account in a manner, for distribution of species in different regions, in accordance with the degree that the different species differ in response to temperature (Brown and Crozier, 1927: 25).

Thus this might explain in a manner the differences of response of northern and southern forms to temperature, and at the same time harmonize with the possible close correlation respectively between geographical range and seasonal distribution of different cladoceran species, as shown in the present paper, as well as by the work of Wasenberg-Lund (1926: 225–226), and Brown (1929: 260, 346) for fresh water forms.

The incompleteness of the available information in regard to the physical environment of the marine cladocers is very unfortunate. These forms, like most plankton organisms, have extraordinary means of dispersal, which would enable them to obtain a completely cosmopolitan distribution. An important restraining factor on their distribution is apparently their different tolerance to the physico-chemical environmental factors. The data at hand strongly support this generalization but their scarcity prevents us from being conclusive on this point.

## THE TAXONOMY OF MARINE CLADOCERA

In the past specific determination of the marine Cladocera has not been generally attended with as great difficulties as in the case of some of the plastic fresh-water species, or local fresh-water races, which undergo extreme changes in superficial appearance, e. g., in crest, posterior and anterior spines. These changes often simulate definitive, specific characters and lead to confusion. In contrast to these fresh-water forms, the nine, more or less definitely distinguishable, marine species are more easily recognized.

However, difficulties, such as the above, and others will be encountered if one attempts to include the species of the Polyphemidæ from the Azov Sea, mentioned by Czerniavski and Madame Pengo (De Guerne, 1887: 358), and those from the Aral and Caspian Seas, discussed by Sars (1897: 1; 1901: 476; 1902: 40), Zernov (1901: 568), and Meissner (1907: 587–592), as some of these species may approach the fresh-water forms in variability.

The work that Woltereck and his co-workers have been doing on the general form changes, etc., on the cladoceran material of regions including the Caspian Sea, may clarify a number of obscure points and disclose some invaluable criteria in regard to the phyletic tree, and bring about a more complete understanding of the specific, generic and group characteristics which may make a more satisfactory revision possible. This looks particularly auspicious when one takes into account the geological significance of the noted region.

In regard to the systematic significance of the various characters used by Sars, Zernov, and Meissner the following statements may be made. The caudal claws as units of specific delimitation are valid. The present writer has readily verified this by the examination of a number of marine species (both fresh and preserved material), and a review of the literature.

On the other hand, some of the criteria employed by Sars (1902), and accepted by others for distinguishing species, appear unreliable from various standpoints. Sars gave little consideration to the fact that the structure of individuals might fluctuate, and thus be misleading under differing attendant circumstances, at various stages of development, and at different times of year.

For instance, Sars' use of such factors as the inclination of the head, extent of cervical depression, size, contour, and also the shape, position and development of the brood pouch, are untenable as determinative, specific characters. In species closely related to *Podon*, as some of these obviously are, the angle of inclination of the head may be dependent on the state of tension of the muscles that move the head. The head is usually inclined approximately, at a more or less constant angle, though by no means consistently.

Furthermore, the shape, position, and development of the brood pouch are doubtful specific characters if used unqualifiedly. According to much available evidence these features are governed by varying intrinsic, as well as extrinsic factors. Again, if preserved material is used, the processes of preservation may cause a distorted or abnormal effect.

As may be inferred from the foregoing statements, and quite in agreement with Rammner (1927a), the writer maintains that a description of a "typical" individual is no longer sufficient. The exact species description must take into consideration age, local, geographical, and "Temporal-Formen" variation, if the complete picture is to be realized. Statistical measurements should be stressed along with form changes (Rhumbler 1915; Rammner, 1927a: 117). Postembryological development of various instars must be considered, as only like stages are apt to agree in general appearance. Even within the instars variations are likely to occur, due to various exigencies.

Although agreeing with those who stress the general body form, the present writer feels that the real crux of the whole matter will eventually be found to lie in a careful and detailed study of the appendages and bristle formulae in the light of evolutionary and embryological development, such as has been made in the works of Behning (1912), and Lityński (1916).

The exopodite formula is a most strikingly constant feature of the appendages of the marine Cladocera, as is borne out by numerous descriptions. However, the number of setae on the joints of the thoracic appendages, as well as the arrangement and even the relative proportion, shape and direction of the caudal claws, and the proportionate lengths of the antennal rami and their joints are quite constant.

It may also be noted in this connection that it is well to take under advisement the suggestions by Lityński (1916: 3) that the groups *Calyptomera* and *Gymnomera* are artificial designations.

The marine Cladocera afford us what might be termed classic examples of true species. The more material that is examined the clearer the case becomes. There is a marked constancy in the bristle formulae, and in the lengths and arrangement of the individual bristles. Here the species have been found to remain true in extremely different temperatures and salinities, in the open ocean or along the coast, and under other varying, environmental conditions.

On the other hand, this should not be interpreted to imply that all the features of the marine cladocers are perfectly constant. Indeed a distinct variability occurs. For instance, in the species, *Evadne nordmanni*, we have in one sample all the different degrees of gradation between a brood pouch with a most rounded posterior margin to that of a decidedly mucronate one. This holds true in all the various instars, and for the different sized individuals, and at different seasons of the year. In other words, in the marine cladocers, as well as in the fresh-water ones, individual species may be recognized in spite of the fact that, as Ferris (1928: 43) stated in a general discussion of the principles of taxonomy, "all sorts of mixtures and intergradations may be found."

*Age Variation:* As is to be expected, there is apparently considerable age variation in the marine Cladocera, although certain essential characters are for the most part the same throughout all the stages, with exceptions mentioned elsewhere in this paper in connection with the differentiation of the mature males.

*Instar Variation:* Determination of the instar is very important in the consideration of variations, and in making various other interpretations. Thus for instance, it is a matter of course that, in the determination of size, the discrimination between immature instars and those of advanced age is imperative.

In examining all the individuals of a rich haul, ranging in size from the smallest to the largest, specimens are often found appearing dark, shrunken, and decrepit-like, along with others fully rounded out and apparently normal. An explanation of this might well be sought in connection with investigations, such as those of Olmsted and Baumberger (1923), dealing with phenomena of the molting of crabs. At least, some of their conclusions seem apropos in this case. These writers maintain that the "visible changes preparatory to molting involve a loss in the brightness of color and a change in the texture of the exoskeleton"; and finally, that the specimen emerges: "from the old shell . . . plump and well filled out" . . . "quite unlike the puckered and wrinkled condition one sees beneath the broken carapace of a premolt" stage, which might be misinterpreted as indicative of senility.

Furthermore, in keeping with this and quite consistent with the findings of various other investigators (Anderson and Brown, 1930: 485; Hesse and Doflein, 1910: 127; Jackson, 1890: 143) on moltings, the individuals of this same group of less well-rounded cladocers frequently have two layers of chitin, presumably in preparation for molting. This latter postulation was readily substantiated by the writer in the dissections of numerous specimens, and this in turn, helped materially in determining and understanding various forms and stages.

*Local and Geographical Variation:* In examining material from a fairly large number of localities, I found that within each species certain characters, i. e., the ones on which I have based specific identification, are strikingly constant under decidedly different conditions. On the other hand, certain features may be more typical in certain regions than in others. In this category are such items as size, shape, and certain proportions of the brood pouches, and the number of eggs in the brood pouch. Yet in the rich samples from Monterey Bay practically all the various modifications recorded for different regions seem to occur in single hauls at the height of the season.

## Special Part

### Family Polyphemidæ (Baird, 1850)

For diagnosis, see Lilljeborg (1901: 592). Of the genera belonging to this family, only two were represented in my material.

### Genus **Podon** (Lilljeborg, 1853)

Head movable; separated from body by deep, cervical constriction. Dorsal pouch oval to subcircular in lateral outline. Buccal area has an investiture of thickly set, minute spinules, increasing in size and decreasing in number away from the mouth. Protopodite of second antenna rather variable in length interspecifically. Endopodite of second antenna with 6 plumose bristles; exopodite with 6–7; the number and arrangement of these bristles constant within species. Second joint of exopodite with 1 bristle; third with 1–2. First and second joints of endopodite each with 1 bristle. Third joint with the same number and types of bristles as two distal joints of exopodite. Mandibles cylindrical, forming right-angled elbows at 0.5–0.6 the distance from the base, flattened and subequally bifurcated distally. Caudal claws, abdomen and postabdomen vary considerably in size and proportion.

For further diagnostic features see Lilljeborg (1901: 625–626).

*Number and Relationship of Species:* There are six marine species (Gibitz, 1922: 97) rather clearly distinguished by the formula of bristles on exopodite of thoracic appendages; *Podon schmacheri* Poppe, 4–4–4–2; *P. trisetosus* Krämer, 3–3–3–; *P. polyphemoides* (Leuckart), 3–3–3–2; *P. schœdleri* Czerniavski, 2–3–3–1; *P. intermedius* Lilljeborg, 2–1–1–2; *P. leuckarti* Sars, 1–1–1–2.

### **Podon polyphemoides** (Leuckart)

Plates 26 and 27

*Evadne polyphemoides* Leuckart, 1859: 262.

*Pleopis minutus* Sars, 1861: 293–4; Sars, 1862: 46.

*Podon Mecznikovii* Czerniavski, 1862: 59–60.

*Podon minutus* de Guerne, 1887: 351–2; Stenroos, 1895: 39–40.

*Podon polyphemoides* Poppe, 1888: 298–9; Sars, 1890: 52; Nordquist, 1891: 119, 121; Krämer, 1894: 222; Lilljeborg, 1901: 633–4; Apstein, 1901: 12; 1911: 118–9; Behning, 1912: 12; Schweiger, 1912: 14–7; Kajdiž, 1912: 934–5; Gibitz, 1922: 90–1; Rammner, 1930: 4.

*Diagnosis:* Bristle formula of exopodites of thoracic limbs: 3–3–3–2.

*Description:* Female —

*Size:* Gross length, inclusive of specimens immediately after emergence, 0.25–0.70 mm.; morphological length, 0.21–0.40 mm.

*Color:* All stages are dull grayish-greenish or have a creamy tinge. Darker than the species of Evadne

*Dorsal Pouch Wall:* In all stages usually less clearly transparent than in Evadne. Cells well marked, giving reticulated appearance, more noticeable than in Evadne.

The following description refers exclusively to mature specimens.

*Body Outline* (Pl. 26, figs. 6–7): Body robust in appearance, with brood pouch of subcircular outline in lateral view, and with deep cervical depression. Head subelliptical; ratio between its long and short axes, about 1.6:1. Abdomen so strongly abbreviated that its tip usually is barely visible in lateral view.

*First Antennae* (Pl. 26, fig. 2): Rudimentary stalks of right and left first antennae merged into a platelike structure about twice as long as wide, or less, with 2 groups of sensory bristles of 5 each; those of male and female similar.

*Labrum* (Pl. 26, fig. 4): Subovoidal, about 1.5 times longer than wide; its anteroventral margin well rounded, decidedly narrower than the base of the organ. A moderate number of stiff and comparatively large spines which show an indication towards grouping. The spines are larger and more powerful than in some of the remaining species of this genus.

*Second Antenna* (Pl. 26, fig. 1): Unusually small, its total length about 5 times the morphological length of body. Protopodite about 0.5 as wide as long, and about 3 times wider than either ramus. Exopodite slightly longer than endopodite; first and fourth joints subequal in length, and about 0.5 as long as the subequal second and third ones. Second endopodite joint about 0.5 the length of the first, and somewhat longer than the third. The most distal joints of the two rami subequal in size. Longest plumose bristles subequal in length to entire appendage; the shortest, which are proximal in position, subequal to length of exopodite. Protopodite with heavy, stout spine proximal to middle of dorsal side; this spine tapers more or less uniformly to a point, in contrast to similarly set spine in the various species of *Evadne.* At least one very minute spine laterally near distal margin of protopodite. Distal joints of both rami have dorsally, near tips, a number of fine, short spines, one of which (shown in figure) is usually heavier, and thus more easily detected.

*Mandibles* (Pl. 26, figs. 3, 5): Right and left members very similar; the portion distal to the pronounced angle 3 times longer than wide. Dorsal main tooth distinctly longer than the ventral; simple, conical, and about twice longer than basal width; a minute, setose protuberance near center of its ventral margin; minute spines sparsely, if at all, investing its medial surface. Ventral main tooth carries distally several, very closely set denticulations, of which the most central ones have collectively a jaggedly spinous, generally roundish distal contour; these denticulations become gradually longer ventrally, and the most distal ones have a tendency to curve gently dorso-medially. Numerous short, sharp, slender spines cover the denticulations at all angles and extend onto surface of main tooth, gradually decreasing in number and size toward the base.

*Maxillae:* Rudimentary, slightly flattened, knob-like, spinose structures, with spinules slightly larger than those nearer buccal cavity.

*First Limb* (Pl. 27, fig. 1): First protopodite joint, which is about twice wider than long, attached to a fairly large, somewhat narrower and irregular peduncle, which may or may not be part of protopodite. Second protopodite joint decidedly narrower than the first, from which it is well set off; nearly twice wider than long, and about 0.5 as long as first protopodite joint. A very small, bract-like structure is set near middle of lateral side of second protopodite joint, slightly extending over base of exopodite. Endite small, about half size of exopodite, plate-like, its rounded end tapering into a thorn-like process, prolonged into a styliform spine. Exopodite about as long as second protopodite joint is wide, somewhat more than twice longer than wide; slightly 3-lobed distally, the middle lobe longest. First endopodite joint about as long as first protopodite joint is wide; its average width about one-third its length. Second and third joints about as long as wide; their total length subequal to one-third the length of first joint.

Near middle of ventral surface of first protopodite joint is a group of about 4 fairly strong spines; other similar or larger groups are scattered on medial surface, as well as on second protopodite joint. A number of filament-like, pliant spines occur medially on second protopodite just above middle proximal part of endite; these have about the same appearance as the grouped spines that are scattered on medial surface of first protopodite. At about middle of lateral surface of endite is a group of 4–5 spines, the tips of which extend to or slightly beyond distal edge of endite. On inner surface of this structure, slightly more dorsally, is a somewhat more numerous group of slightly longer, thinner, and less sharply pointed spines. Each of the three distal lobes of exopodite has a long, setose bristle; the most distal, which is longest, extends slightly beyond tip of endopodite; the most dorsal one is a trifle more than 0.5 the most distal, and is the strongest and least flexible, and furnished with the stiffest setae; the most ventral is intermediate in size and the most delicate. The first endopodite joint has, ventrally, 6 coarse, heavy bristles. One of these, situated near distal end of joint, has about the same thickness as the most distal bristle of the exopodite, although being slightly shorter. The remaining 5 of these bristles, fairly uniformly scattered along the joint, are about 0.5 as long, or slightly less. Of the 2 bristles of the second endopodite joint, one is fairly heavy, gently curved, and more or less pliant, about 2 times as strong, and about 0.33 longer than most distal bristle of exopodite; the other is about one-fifth shorter and correspondingly weaker. The 2 bristles of the distal endopodite joint resemble the longer of the bristles of the penultimate joint.

*Second Limb* (Pl. 27, fig. 2): Slightly shorter than the first. Second protopodite joint quite large, about as wide as long. The first one less than 0.5 the length of the second. At the base of exopodite, second protopodite joint has a small, bract-like structure, rounded distally and slightly extending over exopodite. Endite nearly as long as second protopodite joint; its proximal width about 0.5 its length; ends in 2 powerful, pointed, narrowly conical teeth. Exopodite twice longer than wide, 0.5 as long as first endopodite joint, somewhat lobed ventrodistally. First endopodite joint slightly longer than its proximal width, and about two-thirds the length of corresponding joint of first limb; tapers rather strongly distally. Second and third endopodite joints subequal in length; their total length about 0.5 the length of the first.

Protopodite lacks distinct bristles (i. e., it has only the spinous armament characteristic of many of the surfaces of the thoracic appendages). On lateral side of endite, there is a somewhat larger number of spines than in first limb, and these spines are on the average somewhat longer and weaker. Of the 3 bristles of exopodite, the distal is slightly longer, the others slightly shorter than the corresponding bristles of first limb. First endopodite joint with 6 ventral bristles, of which the most proximal one is situated but slightly proximal to the middle of joint; length of longest of these bristles subequal to proximal width of joint, the shortest only slightly shorter. Of the 2 bristles of the second endopodite joint, one is quite powerful, and about as long as total length of first and second endopodite joints; the other is somewhat shorter and decidedly weaker. The 2 bristles of the third endopodite joint resemble the corresponding bristles of the first limb, but are only about two-thirds as long.

*Third Limb* (Pl. 27, fig. 3): About three-fourths the size of the second, but otherwise very similar to this in general appearance and proportions. The lateral, bract-like structure resembles that of first limb, and is slightly better developed. Endite with subparallel sides, and rounded distal truncation. Exopodite subequal in length to first endopodite joint, which is also somewhat shorter relatively to the two distal joints of this ramus. Protopodite lacks distinct bristles (see second limb). The truncated distal end of endite with 4 sturdy, pointed spines, placed nearly equidistant from each other. The most exterior of these is gently curved and slightly blunted, about twice as long as the remaining ones, and its length is subequal to proximal width of endite. Besides these spines the endite is armed with fine, more or less short spinules arranged in small groups. The bristles of exopodite resemble those of second limb, but are slightly shorter. The endopodite also has the same number of bristles as in the second limb, but these are on the average only about 0.5 as long.

*Fourth Limb* (Pl. 27, fig. 4): Less than 0.5 as long as first limb. Joints of protopodite nearly completely merged. The first protopodite joint about as wide as the rest of limb is long. The main joint of this limb, second protopodite, is closely merged with the endopodite joints(?), is but slightly narrower than first protopodite and subsquarish; the spine at the ventrodistal corner somewhat more than 0.25 as long as the length of entire joint, nearly straight, or but slightly curved, and bluntly pointed. On or near distal margin there are 3 fairly strong spines, the remaining ones show gradual transitions to the minute, spine-like structure characteristic of many parts of the thoracic appendages. Lateral joint, the exopodite joint, subsquarish in outline and subcylindrical; its length less than 0.5 the length of preceding joint. It has 2 strong bristles, the longer of which is about as long as, or even slightly longer than, the entire appendage, the shorter one somewhat more than 0.5 this length.

*Abdomen* (Pl. 27, fig. 7): Comparatively broad, generally more closely similar to this structure in *Evadne* than to that of some of the species of *Podon*. Caudal claws, which are about as long as their proximal width, have gently concave, median margins, usually directed ventrally, ventro-posteriorly or posteriorly; the last direction particularly characteristic of younger individuals. The 2 caudal setae comparatively heavy, with less delicate plumosity than in the species of Evadne.

*Description:* Male —

*Size:* Maximum gross length, 0.54 mm.; maximum morphological length 0.41 mm. (Both measurements found at Monterey Bay.)

*Body Outline* (Pl. 26, fig. 8): Cervical depression near center of dorsal margin, i. e., slightly more dorsal than in female. Head slightly larger, and more broadly arched. Eyes larger, subglobose. Dorsal pouch comparatively small, slightly, if at all larger than head; subconical, with fairly flattened anterior and posterior margins, and fairly broadly rounded apex.

*First Thoracic Limb* (Pl. 27, fig. 5): In mature males the first thoracic limb is similar to that of the female in most respects. The following modifications may be noted: First endopodite joint somewhat shorter, and the second somewhat enlarged. The 2 bristles of the second endopodite joint undergo a decided change. The dorsal one is fashioned into a smooth, somewhat angular hook, of which the length approximates the total length of second and third endopodite joints. Hook recurves sharply ventrally; after tapering from the broadly rounded, enlarged base, this bristle maintains a more or less consistent diameter distally up to the evenly rounded, blunt tip. This rather uniform diameter about equals that of base of bristles of first endopodite joint. Ventral bristle represented by a stiff and fairly stout, rudimentary bristle, set irregularly with small, sharp spines; its length approximately that of the ventral margin of joint.

*Penis* (Pl. 27, fig. 6): Right and left organs similar. The thickly muscular, broad and cylindrical vas deferens curves obliquely antero-ventrally. At least the proximal third of the protopodite portion of the penis is narrowly cylindrical. The distal third is composed of two heavy, muscular parts, tapering to fairly narrowly rounded tips, corresponding to the exopodite and the endopodite; the former appears to be a trifle the shorter. The testes lie slightly ventral to middle of base of dorsal pouch.

*Present Material:* The above description is based largely on material from the following localities: —Frenchmans Bay, Maine; July 18, 1930. —Salisbury Cove, Maine; Aug. 6, 1930. —Baltic Sea, off the coast of Sweden, Ornskölksvik, 63° 15′ N.; No. 2761, T. Tullberg collection; July 1882. —Peter-the-Great Bay, Japan Sea; no data. —Various stations in southern end of Monterey Bay (California), chiefly surface hauls; Jan. 1929–Dec. 1931, inclusive.

*Comparison with previous Descriptions:* This best descriptions so far published are the ones by De Guerne (1887: 351) and Lilljeborg (1901: 633). Although it is not necessary to discuss the various descriptions in detail the following remarks may be made.

The gross length of 0.25–0.70 mm. was found for females of this species from Monterey Bay. Other records of gross lengths are those by De Guerne (1887: 353), 0.50–0.60 mm.; Lilljeborg (1901: 634) 0.6–0.66 mm.; and Rammner (1930: 4), 0.66 mm. Thus the maximum gross lengths for this species do not have a range of more than 0.1 mm., in spite of the fact that material from widely separated localities has been measured.

Apparently, there are no records of morphological lengths in the literature for comparison. However, it should be noted that Schweiger (1912: 18) recorded only 0.37–0.32 mm. as the length of this form. Unfortunately, this writer did not define his method of measurements so his figures may refer to the morphological length.

In the literature, the length of females has been given vaguely as that extending to the end of the brood pouch with the resultant incomplete picture. Few measurements are recorded for the males, and these differ but slightly with the different localities. De Guerne (1887: 353) states size as 0.50 mm.; Lilljeborg (1901: 635) as 0.54 mm.; and Rammner (1930: 4) gives the same measurements as Lilljeborg. These measurements thus nicely approximate the gross lengths given for the material from the Monterey Bay region.

In the literature it has been emphasized that the males are decidedly smaller than the females. This is not altogether in accord with my findings. Incidentally, the males are somewhat difficult to distinguish from the females as the body outline is not strikingly different, and the dorsal pouch is less clearly transparent. The size of the males is slightly different from that of parthenogenetic females which have just released their young (cf., Pl. 26, figs. 7, 8), and from the ephippial females with very small embryos.

The discrepancy is rather apparent than real. The morphological length of the two sexes is practically identical, but this measurement has not usually been taken by previous writers. The larger gross size of the females is due to the excessive development of the dorsal pouch in the process of the development of the embryos. Furthermore it may be that some of the previous writers have measured immature males in the belief that they were mature, a not improbable supposition, considering the scarcity of the males as a whole, and the preponderance of immature ones over the mature.

The immature males show different stages of development of the hook. When this structure first appears it is small, gently and uniformly curved, and tapers practically to a point. Later it increases in length and diameter and at the same time becomes less pointed. In this manner it gradually assumes the type of the "etwas S-förmig gekrümmte Kralle," of which Lilljeborg (1901, Pl. LXXXV, fig. 11) speaks. In the fully mature stage, as can be seen from the descriptions and figures of this paper, it becomes decidedly larger, and more angular. In all probability this structure has previously been figured from specimens that were not fully mature. It may be noted further that it is extremely difficult to secure this hook in an advantageous position for figuring.

A peculiarity in Lilljeborg's figure (1901, Pl. LXXXV, fig. 11) is that the second endopodite joint of the first limb is furnished with a bristle sub-equal to total length of the endopodite. If this feature were correctly figured it undoubtedly would form a sufficient foundation for the specific separation of Lilljeborg's and my material. However, the probability is that Lilljeborg erred on this particular point, although nobody so far has drawn attention to this possibility. This assumption is strongly supported by the circumstance that De Guerne (1877: 355–356, Pl. VI. fig. 7) who examined material gives data well in agreement with my observations.

The two distal joints of the first limb in the male have not been clearly delimited in the previous literature. De Guerne (*loc. cit.*) did not attempt to outline the joints, but merely stated the general regions in which the bristles may be found. Lilljeborg's (1901: 635–636; Pl. LXXXV, fig. 11) work gives the impression of his having observed this limb entirely from the medial or ventral sides, which is extremely disadvantageous, particularly in regard to the discernment of the very distal part of the endopodite. De Guerne is apparently the only investigator heretofore to attempt to homologize the hook of the first limb. He considers it to be a bristle, a view also held by the present writer. Lilljeborg apparently did not consider this problem, judging by the fact that he located this claw or hook erroneously on the third joint.

*Synonymy:* The disentanglement of the species *Podon polyphemoides* is really the history of the genus *Podon*, which was established by Lilljeborg (1853: 161). Realizing the confusion in nomenclature that existed in this genus, Poppe (1888) wrote a rather clear-cut criticism pertaining thereto. Though Lilljeborg (1901: 634) failed to mention this reference in his list of synonyms of *P. polyphemoides*, he was cognizant of it, as also was Apstein in his paper of 1901 and in later ones.

*Geographic Distribution:* Although *Podon polyphemoides* is apparently most prevalent in the coastal waters of the colder regions, it is found also in warmer sections. The type locality, as given by Leuckart (1859: 262), is Nice. Since then, it has been found in other parts of the Mediterranean and north along all European coasts, off the British Isles, and in various other parts of the world as follows:

—Mediterranean Sea (Aurivillius, 1899: 35); —Gulf of Marseilles (De Guerne, 1887: 351–2); —Adriatic Sea (Schweiger, 1912: 14–16); Kajdiž, 1912: 934); —Black Sea (De Guerne, 1887: 352; Aurivillius, 1898: 123; Schweiger, 1912: 14).

—Off coast of Coruña, Spain and West Coast of France, (De Guerne, 1887: 351–2; Aurivillius, 1898: 123; Hansen, 1899: 9); —Sylt (Rammner, 1931: 632); —Zuider Zee, (Redeke, 1922: 334); —Helgoland, (Leuckart, 1859: 262; Apstein, 1901: 15); —various parts of Baltic Sea, (Hensen, 1887: 56; Nordquist, 1891: 119–21; Aurivillius, 1898: 123; Hansen, 1899: 8–9; Apstein, 1901: 15; Driver, 1907: 125; Rammner, 1931: 632); —in Svelvig, Bay of Bothnia, Bay of Finland, south and west coasts and fjords of Norway, (De Guerne, 1887: 351–2; Sars, 1890: 52; Nordquist, 1891: 83, 119–21; Aurivillius, 1898: 123; Hansen, 1899: 8–9; Levander, 1900: 22; 1900b: 14); —along the coast of Norway to Lofoten, and off Murman coast, (Breitfuss, 1904: 9; International Council, 1908–12; Gibitz, 1922: 90); —Skagerack, North Sea, and coasts of British Isles, (Stenroos, 1895: 39–40; Aurivillius, 1898: 123; 1899: 35; Cleve, 1899b: 16; 1900a: 12, 42–3; 1900b: 13; 1902: 23; 1903a: 23; Apstein, 1901: 15; Farran, 1913: 2).

—East Coast of North America, (Cleve, 1901a: 37; Gibitz, 1922: 90), —Narragansett Bay and Woods Hole, New England, (Williams, 1907: 79; Fish, 1925: 140); —off Nova Scotia and New Brunswick, (McMurrich, 1917: 6; Kindle and Whittaker, 1918: 248).

—West and south coasts of southern part of Africa, —off Dutch Southwest Africa, (Gibitz, 1922: 90; Rammner, 1931: 619, 632); —Cape Cross, "Bay of Guinea," (Hansen, 1899: 9); —False Bay, (Apstein, 1901: 15). —Hauraki Gulf, Auckland, (Krämer, 1894: 221; Cleve, 1901a: 34). —West coast of North America, "at various places off the coast of Vancouver Island" (Hart and Wailes, 1932: 247, 251).

See also previous paragraph "Present Material".

*Seasonal Occurrence:* The season of occurrence of *Podon polyphemoides* in the Baltic Sea is summed up by Gibitz (1922: 90) as beginning in May and extending into November, with greatest frequency in August. Hensen (1887: 56) claimed that this species also occurred during the beginning of the year. Aurivillius (1898: 123) ascertained the season in Skagerak as the middle of June to the middle of October. Cleve (1900a: 42) gave the occurrence off Helder from the last of July to nearly the middle of November. Kajdiž (1912: 934) reported findings of this species in the Adriatic and Gulf of Triest during the months of April, May, July and August. Gibitz (1922: 90) stated that this species: "wird an den europäischen Küsten meistens im Sommer und Herbst gefunden". Summarizing from material at hand, Rammner (1930: 26) stated that *P. polyphemoides:* "hat in der Nordsee sein Maximum im Sommer und Herbst, meist in Küstennähe; in der Ostsee kommt er meist nicht häufig vor, ist im V. und XI. sehr selten, erst im VIII. zahlreich, im Finnischen Busen auch noch im IX."

It may also be noted here that Hansen (1899: 8, 9) quoted Brady as saying that this species was: "constantly to be got in the summer months in the surface net all round the British coasts." However, when Brady made his statements *P. polyphemoides* had not been clearly delimited or distinguished from *P. intermedius*, by various workers, hence, it is easily possible that the two were confused by him.

Results harmonizing with those from European waters may be cited for this species off the eastern coast of North America, where it appears off St. Andrews in October (McMurrich, 1917: 6), and off Woods Hole, with greatest frequency noted in August (Fish, 1925: 140).

Thus the seasonal occurrence of *P. polyphemoides* is rather extended. In Monterey Bay this species has been found by the author to occur throughout the entire year. The highest frequencies were noted during the winter months. Lack of pronounced seasonal differences in the hydrography may be the cause of this apparently unusual phenomenon.

It may be seen from this summary that in localities where climatic conditions seem to be more extreme and less stable the seasonal occurrence is considerably curtailed. Furthermore, periods of greatest frequencies vary from place to place and from year to year, as is characteristic of planktonic organisms in general.

In regard to the possibility of a difference between the seasonal occurrence of the sexes, it should be noted that little can as yet be said about this point, on account of the general scarcity of the males. De Guerne (1887: 355) reported males from the first half of September; Lilljeborg (1901: 635), from the end of August to September. In Monterey Bay, this sex was present during the entire month of April and until the end of August. In other words, the season of the males appears to be shorter than that of the females, but the evidence is not conclusive.

*Temperature:* Aurivillius (1898: 123) gave the thermal range as 10.2°–19.8° C. Rammner (1930: 13) stated that: "Die weiteste Verbreitung hat *Podon polyphemoides* als kosmopolitische, ausgesprochen neritische Oberflächenforme, die am häufigsten zwischen 10° und 15° C. angetroffen wird; Grenzwerte sind 2.46° und 17.92°." The temperature range for the Monterey Bay section, from which all the California material came, is from 10°–16°, the most usual, 12°–14° C.

It is interesting to note that the optimal thermal range established by Rammner, viz., 10°–15°, agrees closely with that found in Monterey Bay, where conditions are remarkably uniform, and where the species occurs throughout the entire year.

*Salinity:* The greatest frequency of this species according to Aurivillius (1898: 123) occurs at 21‰. According to Rammner (1930: 6, 12), *P. polyphemoides* can stand pronounced extremes in salinity, viz., from 1.05–35.1‰. "Die offensichtlich sehr grosse Anpassungsfähigkeit der Art an die Salzverhältnisse ermöglicht es ihr, sogar ins Süsswasser einzudringen (nach Lilljeborg im Odelsee bei Ornsköldsvik in Västernorrland, also nicht sehr weit von der Küste entfernt); neuere Funddaten aus Süsswasser sind nicht bekannt". He further stated that the marine *P. polyphemoides*: "ist in der Zuider Zee dagegen zeitweise sehr häufig, und auch Redeke meldet *Podon polyphemoides* aus mesohalinem (1 bis 10 g.Cl in 1 l.) und polyhalinem Brackwasser (über 10 g.Cl) der Niederlande". Apparently then *P. polyphemoides* is strikingly euryhaline.

It may finally be noted that my material from Monterey Bay was well within the extremes of salinity previously established, viz., from 32.5–34.0‰, usual range, 33.5–34.0‰.

## Genus **Evadne** (Lovén, 1835)

Head not movable, not distinct from body; with an evenly vaulted outline. (Slight cervical sinus may be present, depending on the contraction of the muscles.) Somewhat elongated dorsal pouch, variable in shape, subtriangular to broadly ovoid. Spines of labrum comparatively numerous; within respective species similar in general plan, size and shape. Buccal area has an investiture of thickly set, minute spinules, increasing in size and decreasing in number away from the mouth. Rudimentary stalks of right and left first antennae merge into a platelike structure about twice as long as wide, with 2 groups of sensory bristles of 5 each; those of male and female similar. Protopodite of second antenna nearly twice as long as either ramus; 2–3 times longer than wide. Rami subequal in length; each ramus about 3–4 times as long as wide. Lengths of second and third exopodite joints quite similar; also those of first and second endopodite joints. The three distal joints of exopodite similar to the three endopodite joints. Most distal joints of the two rami about equal in size; approximate in length the first exopodite joint. Proximally on middle of dorsal side of protopodite there is heavy spine, consisting of a styliform tip with a conical expansion at base. Each ramus furnished with 6 flexible, delicately plumose, hyaline bristles. Bristle absent on first exopodite joint; second and third exopodite joints each with 1 bristle; the fourth with 4. Endopodite with same number and types of bristles at the three distal joints of exopodite. On the dorso-distal tip of margin of each ramus is at least one small, slender, extremely delicate, sharp spine, directed dorso-distally (often not clearly discernible, at first, due to the hyaline, refractive character and minuteness). Mandibles cylindrical, forming right-angled elbows at 0.5–0.6 the distance from the base, flattened and subequally bifurcated distally. Maxillae rudimentary, represented by patches of spinules immediately posteroventral to mandibles. Exites not in evidence on thoracic limbs. Endite of first limb extremely rudimentary. Special modifications take place in joints and bristles in males. Investiture of spines and bristles on thoracic limbs strikingly similar within species. Caudal claws comparatively constant in size.

For further diagnostic features, see Lilljeborg (1901: 639–40).

*Number and Relationships of Species:* The three marine species are easily distinguishable by the number of bristles of the exopodites of the thoracic appendages: *Evadne tergestina* Claus 2–3–3–1; *E. spinifera* Müller 2–2–2–1; *E. Nordmanni* Lovén 2–2–1–1. The two elevator muscles of each of the second antennae diverge dorsally in both *E. tergestina* Claus, and *E. spinifera* Müller; those of *E. nordmanni* Lovén are more or less parallel.

Of the three known marine species of this genus, *E. tergestina*, in so far as known, is intermediate in both morphological and maximum gross length, in size of head, brood pouch, length of second antenna and limbs, and relative length of bristles, while *E. spinifera* has greatest measurements in these respects, except for brood pouch, which is relatively the smallest. The brood pouch of *E. nordmanni* is the largest. Relative lengths of bristles of *E. nordmanni* closely simulate those of *E. tergestina*. Labrum of the former species is rhomboidal with rounded corners, and is the smallest in the genus; that of the latter species is intermediate in size and general contour. On the other hand, the mandibles of *E. tergestina* are the broadest, and are supplied with the coarsest teeth; mandibles of *E. nordmanni* are slightly less coarse than those of *E. spinifera*, and are generally similar to those of this species in major denticulations; they are invested with a greater number of spinules than either of the other two species in the genus. It may be added that as far as known *E. nordmanni* has the most striking form variation.

The following table gives the number of bristles of exopodites and endopodites of the thoracic limbs of the three best known species of *Evadne*, and tends to indicate more clearly the structural relationships among these forms.

Tabulation of Bristles of Female

| | *Limb* | *Exop.* | *1st Endop.* | *2nd Endop.* | *3rd Endop.* |
|---|---|---|---|---|---|
| *E. tergestina* | 1 | 2 | 6 | 1 | 2 |
| | 2 | 3 | 4 | 2 | 2 |
| | 3 | 3 | 2 | 2 | 2 |
| | 4 | 1 | ? | 2? | 2? |
| *E. nordmanni* | 1 | 2 | 4 | 1 | 2 |
| | 2 | 2 | 2 | 2 | 2 |
| | 3 | 1 | 2 | 2 | 2 |
| | 4 | 1 | ? | 2? | 2? |
| *E. spinifera* | 1 | 2 | 4 | 1 | 2 |
| | 2 | 2 | 4 | 2 | 2 |
| | 3 | 2 | 3 | 2 | 2 |
| | 4 | 1 | ? | 2 | 2? |

In regard to the bristles of the remaining appendages, first and second antennae, and mandibles it may be noted that all the species are similar. First antenna has 5 bristles; the second, 6 on both the exopodite and endopodite.

As will be seen from these data, the various characters have probably evolved independently of each other. As a consequence, we cannot state that any one species is the most primitive, or the most advanced in every respect. On the contrary, the various species are rather advanced in some respects, while they have remained more or less primitive in others. At the same time it may be stated, that, by and large, *E. tergestina*, occupies an intermediate position within the genus. *E. tergestina* rather strikingly illustrates independent evolution of the individual features. In spite of its intermediate position, it appears, at least in the bristle formula of the thoracic limbs, to be closest to *Podon*.

## **Evadne tergestina** Claus

Plate 28

*Evadne mediterranea* Claus, 1862, (part.): 245.

*Evadne tergestina* Claus, 1877: 140; De Guerne, 1887: 355, note 1; Hansen, 1899: 9, 11; Juday, 1907: 157; Schweiger, 1912: 11; Kajdiž, 1912: 932–933; Gibitz, 1922: 90, 93; Rammner, 1931: 620–632.

*Evadne aspinosa* Krämer, 1894: 222.

*Diagnosis:* Bristles of exopodites of thoracic limbs 2–3–3–1. Elevator muscles of second antenna diverge dorsally.

*Description:* Female —

*Size:* Gross length, inclusive of specimens immediately after emergence, 0.30–1.30 mm.; maximum morphological length, 0.55 mm.

*Color:* General coloring dark creamy, more or less intermediate between that of *E. nordmanni* Lovén and *Podon polyphemoides* (Leuckart). Often with several, more or less conspicuous rows of darkly pigmented cells, giving appearance of uniformly interrupted, lateral lines.

*Dorsal Pouch Wall:* About same degree of transparency as *E. nordmanni* Lovén, but somewhat less so than *E. spinifera* Müller. Even old specimens are characterized by clearly marked, polygonal cells in brood pouch. When brood pouch is broad, these cells are decidedly elongated, with their long axes perpendicular to greatest length of pouch (Rammner, 1931, fig. 2).

*Elevator Muscles:* Diverging dorsally, forming an angle of about 15°; similar to those of *E. spinifera* Müller.

The following description refers exclusively to mature specimens.

*Body Outline:* (Pl. 28, figs. 1–2): Brood pouch decidedly variable in shape. Anterior margin broadly and fairly uniformly convex. Postmargin either of about the same convexity as the anterior, or nearly straight, or with a more or less pronounced sigmoid outline, convex ventrally. Dorsally the pouch is rather broadly to rather narrowly rounded, without spine or mucro.

*Labrum* (Pl. 28, fig. 4): Oval to somewhat reniform with broadly rounded antero-ventral margin; antero-dorsal margin shortest in this genus, but longer than that of *Podon polyphemoides* (Leuckart). Spines somewhat scattered, but still with the distinct appearance of grouping; comparatively large for this genus, but decidedly smaller than in *Podon polyphemoides* (Leuckart).

*Second Antenna:* Length intermediate; total length about 5 times the morphological length of body. Protopodite also intermediate, when compared with length of rami; its length about 3 times its width. Penultimate joint of each ramus about 1.4–1.7 times longer than respective distal joints. The 2 most proximal, plumose bristles of both rami 0.50–0.66 the length of those on respective distal joints, which are subequal; of the latter bristles those of postero-ventral margins are longest.

Small bristle of each distal joint about 0.33 the length of the respective joint; slightly better developed than in other members of genus. The conical base of the proximal dorsal spine of the protopodite is about 0.5 the length of the styliform tip or less.

*Mandibles* (Pl. 28, figs. 3, 5): Right and left members quite similar. The lesser denticulations of ventral major tooth of right member appear slightly less incised than those of the left (however, this feature was extremely difficult to establish with full certainty on my limited material). The portion distal to pronounced angle comparatively short and broad; ratio between length and width, about 3:1. Dorsal major tooth comparatively short and broad, its outline in lateral view subequilateral; smooth and well pointed or slightly blunted. The ventral main tooth is slightly less strong, and somewhat longer than the dorsal. It is furnished with a strong, bifurcated projection on its dorso-distal margin; the 2 points of this projection are of markedly unequal length, the more ventral one being approximately twice the length of the other. Ventro-distally it is cleft into groups of jaggedly spinose dentations or serrations.

*First Limb* (Pl. 28, fig. 6): First protopodite joint more than 0.5 as broad as long. Second protopodite joint nearly as broad as long, and about 0.5 the length of the first joint. Endite rudimentary, consisting of a small, roundish lobe usually furnished with at least 1–2 more or less prominent spines. Exopodite about twice longer than wide, and slightly longer than 0.5 the length of first endopodite joint. Length of first endopodite joint averages 2 times the width, which is less than 0.75 the width of second protopodite joint. Second endopodite joint distinctly shorter than wide, and its length about 0.3 the width of the second protopodite joint. Third endopodite joint has the same relative proportion, and about three-fifths the size.

Exopodite furnished with 2 long, narrow, flexible bristles of approximately the same structure; the more dorsal about 2 times the length of endopodite; the ventral slightly more than 0.66 the length of the dorsal. Ventral surface of first endopodite joint furnished with 6 bristles, four of these arranged in pairs, viz., the second and third, and the two most distal ones. One of the most distal pair is the longest, and about 0.25 longer than exopodite; the shortest of these bristles is but slightly shorter than exopodite. The single, ventro-distal bristle on second endopodite joint slightly more than 0.5 the length of the dorsal bristle of exopodite and about equally well-developed. The 2 distal bristles of third endopodite joint stronger than the dorsal one of exopodite, and about 0.66 its length.

*Second Limb* (Pl. 28, fig. 7): Practically of the same length as first limb. Dimensions of first and second protopodite joints closely approximate the corresponding ones of first limb. Width of first protopodite joint about four-fifths the length. Width of second protopodite joint subequal to length. Length of endite about equal to that of second protopodite joint; its greatest width nearly 0.66 the length. There are 2 large, tooth-like, bluntly pointed projections on distal margin, set at slightly divergent angles. Exopodite slightly less than 2 times as long as broad, and about 0.8 the length of exopodite of first limb, slightly 3-lobed distally. First endopodite joint about 0.8–1.0 its width, and about 0.6 the length of the corresponding joint of first limb. Width of second joint is 3 times length. Width of third joint about twice its greatest length. These two joints are quite similar in dimensions to the corresponding ones of first limb; however, the distal one is more narrowed distally.

A prominent tooth-like, stiff spine is set on posterior margin of endite a short distance from the 2 distal teeth. Distal and posterior margins of endite as well as nearly all of the medial surface bear irregularly grouped, more or less scattered bristles; some of those on the distal, lateral margin approach the major teeth in length. Each of the 3 minute, irregular, lobe-like prominences of the distal margin of the exopodite set with a bristle, the middle of these is about 0.66 the length of the dorsal bristle of the exopodite, and about 0.60 the length of exopodite of first limb; the most dorsal is about 0.7, and the most ventral 0.8 of the middle one. The 4 bristles on the ventral margin of the first endopodite joint are arranged more or less in pairs. Two of them, at extreme distal margin, are set close together, and are equal in length and subequal to the shorter of the corresponding ones of the first limb. The remaining bristles, somewhat proximal to the middle of the ventral margin of second endopodite joint, have mutually the same relative length as those on the distal joint; the longer is 0.75 the length of the corresponding one of the first limb. Third endopodite joint with 2 bristles of unequal length; the shorter, ventral one about 0.1 the length of the dorsal, which is slightly less than the corresponding one of first limb.

*Third Limb* (Pl. 28, fig. 8): Length about 0.75 that of second limb. Protopodite joints of the same relative proportions, but slightly smaller than the respective ones of second limb. Endite is similar, yet slightly broader and shorter than that of second limb, and has more gently rounded margin; there are 2 fairly narrow, more or less blunt and curved tooth-like projections. Width of exopodite about 0.7 the length; length about 0.75 the exopodite of second limb; otherwise closely similar in structure. First endopodite joint somewhat squarish, and about 0.75 the length of corresponding joint of second limb. The second and third endopodite joints practically of the same dimensions as those of second limb.

Spines of the endite are quite similar in general arrangement as those of second limb, but slightly shorter. Investiture of bristles of exopodite similar to that of second limb; middle bristle practically the same length as that of second limb; dorsal bristle slightly longer than the dorsal. The 3 bristles of the first endopodite joint subequal in length; one is set fairly near the proximal end of the joint, the other 2 near the distal end; all are about equal to the 2 most proximal bristles on the corresponding joint of second limb.

*Fourth Limb* (Pl. 28, fig. 9): Nearly 0.5 the total length of first limb; its width about 0.66 the width of the first protopodite joint of first limb. First protopodite joint about 0.5 as broad as long. Second protopodite joint but slightly longer than broad; its width about same as that of first protopodite joint. Endite (?) has apparently deteriorated into a coarse, stout, sharply pointed spine. Exopodite intermediate in the genus in size and structure; its length about 0.25 that of second protopodite joint. Length of its distal bristle slightly less than total length of limb, and less than 0.5 the dorsal bristle of the exopodite of first limb.

Endopodite is more compact than in other members of the genus. It is furnished with 4 bristles of about equal length, which is slightly less than 0.5 the length of exopodite bristle. Two of these bristles set ventrally; the other 2 bristles situated more distally and slightly dorsal on a narrow lobe.

*Abdomen:* (Pl. 28, fig. 10): Narrowed; length closely approximates that of *E. nordmanni* Lovén. Caudal claws usually directed antero-ventrally. The 2 caudal setae shorter than those of other members of genus, and with less extensive plumosity.

*Description:* Male —

Since no males were seen by the writer, references are made to Claus (1877: 136–137, Pl. V, figs. 16, 17, 17[1]) for descriptions.

*Present Material:* Off southern California, 34° 05′ N. Lat., 119° 28′ W. Long., surface; July 28, 1930.

*Comparison with Previous Descriptions:* The gross maximum length of the present material was 1.17 mm., thus slightly larger than that previously recorded by Juday (1907: 157) for the same general region. Other measurements are those of Schweiger (1912: 18), 0.85, and Rammner (1931: 626), 1.30 mm. Rammner recorded 0.30 mm. as the smallest gross length. The gross length variation of the species as a whole is evidently considerable.

As no morphological length appears to have been previously recorded for this species, no comparisons can be drawn with that of the present material. However, without defining his method of measurement, Schweiger (1912: 18) stated that: "die Höhe fast immer mehr als die Hälfte der Länge."

Evidences of pigmentation noted on the body wall of the brood pouch are more or less consistent with observations by Claus (1877: 142). The polygonal cells on the brood pouch walls are consistent with findings by Rammner (1931: 622–3, fig. 2) and generally agree with Claus 1877: 141–142) on the existence of such cells.

The general contour comes within range of descriptions and figures of previous workers including Claus (1877, Pl. V, fig. 15). Juday (1907: 157), and Rammner (1931: 621–627, figs. 1, 2, 5).

According to the literature, the appendages of *E. tergestina* have not been dissected out and figured separately, with the exception of a few, more or less inadequately analyzed by Krämer (1894, Pl. XXII, figs. 1–8). These figures are but most general sketches of questionable accuracy. Considering this, it is impossible to discuss them satisfactorily in detail.

However, the drawings of the present paper, in so far as comparable, are consistent with drawings of the entire specimen as figured by Claus 1877, Pl. V, figs. 15, 15′, 18), Juday 1907: 158), and Rammner (1931, figs. 1, 2, 5). In none of these references was a detailed appendage delineation apparently a primary concern.

*Synonymy:* Claus (1877: 140, note 1) acknowledged, that this species was probably described in an earlier paper of his (1862: 245), in part as *E. mediterranea* (De Guerne, 1887: 355, note 1). Krämer (1894: 222) proposed *E. aspinosa* as a new species, but Hansen (1899: 9, 11) rejected this step, and properly reduced the name to a synonym of *E. tergestina* before any confusion resulted.

*Geographic Distribution: Evadne tergestina* is one of the most prevalent species of the Torrid Zone, according to present data, and extends into some of the milder regions of the Temperate Zones. The type locality appears to be the Gulf of Triest (Claus, 1877: 140).

Additional localities in this general region include those for the Gulf of Triest, and Gulf of Quarnero, (Schweiger, 1912: 11); (Kajdiz, 1912: 932); —stations in the Mediterranean, (Cleve, 1902: 370); —Suez Canal, (Gurney, 1927: 137–72); and the Red Sea; —station 16° N. Lat., 42° E. Long. (Cleve, 1903b: 370).

Other recordings: —North Equatorial Stream and Sargasso Sea; —Florida Stream; off Bermuda Islands, (Hansen, 1899: 11–2, Cleve, 1901a: 36; Hensen, 1911: 324; Rammner, 1931: 621, 632); —East Coast of North America, —Woods Hole region (Fish, 1925: 130–40).

—Azores; Cape Verde Islands; —African coasts, including Bay of Guinea; —Freetown; —Atlantic Ocean, 3° N. Lat., 4° E. Long.; —"Cotonu" (?) Capetown; as well as, at 23° 8′ S. Lat., 39° 40′ W. Long. in South Atlantic; —Indian Ocean, 19° 52′ N. Lat., 90° 11′ E. Long.; and 4° 56′ N. Lat., 95° 16′ E. Long.; —south of

Ceylon; —off Sumatra; —Banks Strait; —Java (Anjer); —Formosa; —Taka, New Guinea; —Volcanic Islands; 5° 18′ S. Long.; —St. Georges Channel; —Bougainville (Hansen, 1899: 11–13); Cleve, 1901a: 36; 1901b: 4; Hensen, 1911: 432; Scott, 1912: 580; Rammner, 1931: 621, 632); —off Auckland, and —"in Jervis Bay, near Sidney" (Krämer, 1894: 214), —Freemantle (Hansen, 1899: 11).

—Off North American west coast; —Nootka, B. C. (Hart and Wailes, 1932: 247–51); and —"at various places off the coast of southern California", San Diego region (Juday, 1907: 158).

See also previous paragraph "Present material".

*Seasonal Occurrence:* Data on the seasonal occurrence of *Evadne tergestina* are for the most part lacking. Cleve (1901b: 4) found this species off Sumatra in March; Schweiger (1912: 3–5) recorded its occurrence from July 15 to September 5; Kajdiz (1912: 918–919) reported the months of April, July to October. Of its occurrence off Woods Hole region, Fish (1925: 139) wrote: "*Evadne tergestina,* new to this region, appeared on May 20, becoming very numerous by July 1. During the summer diatom maximum the numbers decreased, but rose again in September. After that they declined until November, the last being recorded on November 15." Rammner (1931: 620) stated that: "in dem von mir durchgesehen Material kommt *E. tergestina* von April bis November vor, allerdings an verschiedenen Fundorten." Present material was taken June 28, 1930.

This seasonal occurrence is consistent in general with the prevalence of the species in the warmer regions of the seas. It should be noted that of various localities in which this species has been found a number are not restricted to comparatively warm regions.

*Temperature:* Cleve (1901a: 36) gave the temperature range as "22.2° to 27.8°". The temperature in the Bitter Lakes of the Suez Canal zone, where this species was found in great abundance by Gurney (1927: 141–2) is very high. The distribution of the species as given in this paper indicates rather conclusively that regions of high temperatures furnish the most suitable environment for this species.

The present material was taken from off the coast of southern California at a temperature of 15.7° C.

*Salinity:* Cleve (1901a: 36) stated the salinity for this species as being "35.25 to 36.85, exceptionally 32." Gurney (1927: 142) says: "it is particularly interesting to note with what vigour it has established itself in the Bitter Lakes in the region immediately over the salt beds" of the Suez Canal. According to data at hand, this species appears to be the most tolerant of the marine Cladocera to the highest salinities.

## **Evadne nordmanni** Lovén

Plates 29, 30

*Evadne nordmanni:* Lovén 1835: 168; Goodsir, 1842: 366; Baird, 1851: 114; Leydig, 1860: 247; Sars, 1862: 54; Sars, 1890: 14; Nordquist, 1891: 119–120; Stenroos, 1895: 40; Lilljeborg, 1901: 642; Apstein, 1901: 12–3, Apstein, 1911: 17–18; Behning, 1912: 10; Schweiger, 1912: 5; Kajdiž, 1912: 929–931, Gibitz, 1922: 90, 94–95; Rammner, 1930: 4.

*Diagnosis:* Bristle formula of exopodites of thoracic limbs 2–2–1–1. Elevator muscles of second antenna more or less parallel.

*Description:* Female —

*Size:* Gross length, inclusive of specimens immediately after emergence, 0.36–1.24 mm.; morphological length, 0.20–0.50 mm.

*Color:* Somewhat variable; pinkish, yellowish, grayish to creamy white, or quite colorless.

*Dorsal Pouch Wall:* Of distinct, although moderate transparency. Polygonal cells considerably less distinct with age.

*Elevator Muscles:* Practically parallel.

The following description refers exclusively to mature specimens.

*Body Outline:* (Pl. 29, figs. 6–7): Brood pouch strikingly variable in shape. Anterior margin often broadly and subuniformly convex, the degree of convexity being somewhat different in different specimens; or it may be slightly undulating, being depressed near the middle. Posterior margin may be straight, but is usually more or less sigmoid; in the latter case the convexity may be dorsal or ventral, a fact that contributes to the pronounced variations in habitus. Dorsally the pouch is usually narrowly rounded, but the convexity may be quite broad. In scattered localities the apex is often more or less mucronate, and maximum length of the mucro being about 0.1 of length of nuchal gland. A slight cervical depression may be present when elevator muscles are contracted.

*Labrum* (Pl. 29, fig. 4): Slightly oblongate with rounded-truncate anterio-ventral margin; antero-dorsal margin intermediate in length in genus. Spines small, moderate in number, and with distinct arrangement in groups.

*Second Antenna* (Pl. 29, fig. 1): Length smallest in genus; total length about 5 times the morphological length of body. Protopodite shortest in genus, when compared with length of rami; its length somewhat less than 3 times its width. Penultimate joint of each ramus about 1.3 times longer than respective distal joints. Plumose bristles of endopodite subequal in length. The 2 proximal ones of exopodite are only about 0.5 the length of remaining plumose bristles, which approximate those of endopodite. Small bristle dorsally near tips of distal joint of each ramus, minute, about 0.25–0.33 the length of the respective joint. The conical base of the proximal, dorsal spine of protopodite about 0.33 the length of the styliform tip.

*Mandibles* (Pl. 29, figs. 3, 5): Right and left members similar. The portion distal to the pronounced angle about 4 times longer than wide. The two major teeth are of approximately equal length, or the ventral is but slightly longer. Dorsal major tooth smooth, conical, and moderately narrow; it tapers fairly suddenly to a narrowly rounded tip; its length is approximately 1.5 times its basal width. Ventral major tooth is deeply bifurcated by a narrow notch into subequal teeth. The dorsal of these teeth is the broader and shorter, and somewhat widened distally, and irregularly armed with stiff, short spines, which are more numerous distally. The ventral tooth is comparatively narrow, armed along entire length with minute, more or less distally directed, slender, stiff spinules, set at different angles and planes.

*First Limb* (Pl. 29, fig. 10): First protopodite joint about 0.75 as wide as long. Second protopodite joint subsquarish in outline, and about 0.5–0.6 or less than the length of first protopodite joint. Endite consists of a fairly small lobe, set with at least one medium-sized spine. Exopodite about 0.35 as wide as long, and about 0.5 as long and 0.25 as wide as first protopodite joint. First endopodite joint twice longer than wide, and about 0.5 as wide as, and subequal in length to, second protopodite joint. Second and third endopodite joints subequal in length, their total length approximating 0.5 the length of first endopodite joint; second joint slightly shorter than wide; third joint subsquarish, diminishing somewhat in breadth distally.

Exopodite with 2 rather long, pliant bristles; the dorsal of these about twice the length of endopodite; the ventral slightly shorter and weaker. First endopodite joint with 4 ventral, subequal bristles, 0.25–0.33 the length of the dorsal bristle of exopodite. One of these bristles is set distally; the 3 remaining ones are fairly close together somewhat proximal to the middle of joint. Ventrodistal bristle of second endopodite joint about 0.6 the length of the dorsal bristle of exopodite. Third endopodite joint with 2 distal bristles, similar to, but slightly shorter than, bristles of exopodite.

*Second Limb* (Pl. 29, fig. 11): Somewhat shorter than first limb. First protopodite joint about 0.6 the length of second protopodite joint, and slightly greater in width; also it is only about 0.4–0.6 the length of this joint of first limb. Second protopodite joint about as wide as long, and closely comparable in size to that of first limb. Endite about 0.75 the length of second protopodite joint, and about 0.5 as wide as long; narrowed distally into two more or less prominent, conical teeth; medial tooth sharply pointed; lateral one slightly blunted. Exopodite about 0.66 the length of exopodite of first limb and of first endopodite joint; about twice longer than wide. First endopodite joint quite wide proximally, tapering rather strongly distally; length and proximal width subequal. Second and third endopodite joints fairly closely approximate size and proportions of those of corresponding ones of first limb; their total length about 0.5 length of first endopodite joint.

Spines on lateral surface of endite less numerous and more uniformly arranged near ventral edges than the more scattered and slightly longer ones on medial side. The 2 bristles of exopodite less pliant, and about 0.6 the length of those of first limb. First endopodite joint with 2 ventral bristles of subequal length; one of these set slightly proximal to middle of ventral margin; the other situated near distal margin of joint. They are shorter than corresponding ones of the first limb, their length being less than proximal width of joint. The 2 bristles of second endopodite joint about as long as first endopodite joint is wide proximally, and about 0.6–0.7 the length of those of third endopodite joint. The 2 bristles of third endopodite joint subequal in length, and about as long as endopodite; their length only about 0.5 the length of the longer of the corresponding bristles of first limb.

*Third Limb* (Pl. 29, fig. 12): Slightly smaller than second limb. Although slightly smaller, the 2 protopodite joints are closely similar in general proportions to those of the second limb. Endite is similar in length, though slightly broader than that of second limb. Exopodite about 0.6 the length of exopodite of second limb, and its length and proximal width are subequal. First endopodite joint subsquarish, more or less rounded ventrally; its length about 0.8 the length of corresponding joint of second limb. Second and third endopodite joints fairly similar to those of second limb; their total length is subequal to 0.5 the length of first endopodite joint.

Spines of endite relatively shorter than corresponding ones of the second limb. Exopodite furnished with a single bristle, about equal in length to ventral bristle of exopodite of second limb. Endopodite furnished with bristles of about the same number, proportions and arrangement as endopodite of second limb; bristles fairly short; the longest, one of the distal ones, subequal in length to endopodite.

*Fourth Limb* (Pl. 29, fig. 13): Slightly narrower than first protopodite joint of first limb, and about 0.5 its total length. First protopodite joint about 0.4 as long as broad. Second protopodite joint about 0.7–0.8 as broad as long, and distinctly narrower than first protopodite joint. Endite (?) apparently degenerated into a sharply pointed, robust spine set on a slight eminence, and in length approximating basal width of exopodite bristle. Exopodite more or less lobe-like, with base broader than length; its length about 0.15 that of second protopodite joint. The single, strong, distal bristle about 0.7 the length of the entire limb, and about 0.33 that of the dorsal bristle of the exopodite of first limb.

Endopodite is a rudimentary, lobe-like projection. A slight depression in its ventral margin is suggestive of a coalesced joint. Immediately distal to this depression are 2 heavy, stiff, slightly curved bristles, about 0.33 the length of the exopodite bristle. Slightly more distally, on a narrowed lobe, are 2 similar bristles, the longer of which is about 0.5 the length of the exopodite bristle, the other about 0.4.

*Abdomen* (Pl. 30, fig. 5): Apparently the widest in this genus, and intermediate in length. Caudal claws usually directed posteriorly, or slightly postero-ventrally. The 2 caudal setae intermediate in length and proportion in genus, and closely comparable with those of *Podon polyphemoides* (Leuckart).

*Description:* Male —

*Size:* Gross length, inclusive of specimens immediately after emergence, 0.37–0.83 mm.; morphological length, 0.22–0.40 mm.

*Body Outline* (Pl. 29, fig. 8): Head slightly larger than in female, and more strikingly and uniformly arched, particularly on ventral aspect. Dorsal pouch fairly constant in shape. The anterior and posterior margins nearly straight, or but slightly undulating, or sigmoid. Dorsal margin narrowly rounded to pointed, forming an angle of about 25° to 35°.

In mature males the thoracic limbs appear generally similar to those of the females, except for proportions of second and third endopodite joints of first limb, and for certain modifications of bristles on the second and third endopodite joints of the first, second, and third limbs.

*First Limb* (Pl. 30, fig. 1): Second endopodite about 0.5 the length of first, and 0.75 the width. Third endopodite joint about 0.25 the length of the second, and less than 0.5 its width. On the second endopodite joint there is a rugose, short, stout, pointed spine at the middle of dorsal margin, and, presumably on dorso-distal edge of the same joint, a small, semi-circular, smooth hook, recurved dorsally from its broadly bulging base; this hook, which is of subuniform width throughout most of its length, and ends in a sharply decurved tip or barbule, has a diameter approximating 0.16 the length of the joint. The curvature of the hook varies considerably with the state of contraction of the muscles of this organ. One of the 2 bristles of third endopodite joint is about 0.6–0.7 length of bristles of exopodite, and slightly more than total length of endopodite; the other is about 0.2 shorter. These bristles are differentiated into fairly robust structures with gently recurved, blunt distal ends. Their proximal 0.25–0.50 furnished with sparsely set spines; distal 0.50–0.75 bearing extremely minute, closely set spinules.

*Second Limb* (Pl. 30, fig. 2): Of the 2 distal bristles on the second endopodite joint, the ventral is fairly similar to that of female; the dorsal resembles the bristles of third endopodite joint of first limb, but its distal third is narrower, and the minute, closely set spines are restricted to this part. The 2 bristles of the third endopodite joint of unequal size, and modified in the same manner as those of the first limb; the more dorsal is slightly longer than total length of endopodite, the ventral about 0.7 the dorsal, and is less recurved distally.

*Third Limb* (Pl. 30, fig. 3): Bristles of second endopodite joint of about the same type as those of second limb, but the dorsal one is less recurved distally. Bristles of third endopodite joint also less recurved distally; the dorsal subequal to total length of endopodite, and weaker than the ventral, which is slightly the shorter.

*Penis* (Pl. 30, fig. 4): Right and left organs similar. Proximal part comparatively wide. Distal 0.50–0.66 composed of 2 elongated, subcylindrical parts, endopodite and exopodite, of subuniform width, with comparatively broadly rounded tips. Exopodite slightly the shorter. Vas deferens but slightly curved, tapering slightly distally.

*Present Material:* The above description is based on material from widely scattered localities: —Frenchmans Bay, Maine, July 18, 1930; —Salisbury Cove, Maine, Aug. 6, 1930; —Firth of Clyde, S. W. Scotland, May, 1919, and Sept. 9, 1918; —Plymouth, England (off coast), no data; —Off coast of Bergen, Norway, No. 2750, Lilljeborg collection, Sept. 11, 1858; —Off coast of Sweden, Baltic Sea, in vicinity of Dalarö, 59° 10′ N. Lat., No. 2747, Lilljeborg collection, Aug. 20, 1894; —Peter-the-Great Bay, Japan Sea, no data; —Southern end of Monterey Bay (California). chiefly surface hauls, Jan. 1929–Dec. 1931, inclusive; —Off coast of southern California, 33° 10′ N. Lat., 119° 30′ W. Long., surface, June 16, 1930; —32° 10′ N. Lat., 122° 05′ W. Long., 40 m. to surface, June 17, 1930; —34° 05′ N. Lat., 119° 28′ W. Long., 50 m. to surface.

*Comparison with Previous Descriptions:* There appears to be a considerable variation in the length of this species in different localities. Lovén (1835: 168) recorded the length of the female as about .05 mm.; Müller (1868: 222), "longit. 0.4–0.5 mm., alt. ad 0.8 mm."; Apstein (1901: 15), 0.4–0.8 mm.; Lilljeborg (1901: 642), 0.94–1.12 mm.; and Rammner (1930: 4), 1.00–1.20 mm. In Monterey Bay this species had a gross length of 0.36–0.92 mm., while in the waters of southern California it reached 1.24 mm. Rammner (1930) also gives the morphological length. His value, 0.50 mm., is nearly identical with the one from the southern California material, 0.48 mm., but decidedly larger than that from Monterey Bay, 0.20–0.42 mm.

In regard to the size of the male, the variations in length appear to be even more pronounced. Lovén (1838: 145) gave 0.38–0.44 mm. De Guerne (1887: 353) 0.50 mm.; Lilljeborg (1901: 646) about 1 mm.; Rammner (1931: 4) spoke of the males as but little smaller than the females. The males from Monterey Bay and Peter-the-Great Bay, of Japan Sea, were within the range established by these writers. In all probability the low values of Lovén may be partly ascribed to immature specimens.

The color of the Monterey Bay specimens was pinkish, yellowish, grayish to creamy white, or quite colorless. Fish (1925: 139) states the coloring to be pinkish white. Sharp (1911: 435) describes it as grayish white to yellowish.

The account of the body contours given by Rammner (1931: 623, fig. 3) is misleading, in so far as it infers that the variations are geographical in nature. There is included within certain samples of material from Monterey Bay those which approximate every outline shown by Rammner along with continuous intergradations. Other samples examined by the present writer from the Peter-the-Great Bay of Japan Sea contain most of the outlines shown in Rammner's figure cited above. In other words, there undoubtedly is a connection between the number of embryos and the shape of the dorsal pouch, but, since the variations in the number of embryos is not in all cases limited geographically, it follows that the differences in the body shape are not necessarily of geographical nature.

In speaking of the structure of the distal part of the endopodite of the first limb in the male Lilljeborg (1901: 646) stated: "Der vordere Theil des Endgliedes dieses Fusses ist in einen ziemlich starken, nach vorne gekrümmten Haken umgewandelt. Hinter diesem findet sich in demselben Gliede ein kleiner, mit einem grossen gekrümmten Borstchen versehener Absatz; in der äusseren Seite trägt das vorletzte Glied ein ähnliches Endborstchen." Lovén (1838: 157) considered the distal joint of this endopodite to have been transformed into the hook. Leydig (1860: 248) adopted Lovén's interpretation. Apstein (1911: 18), citing Lilljeborg as authority, merely restated his view by saying that the "Ende des 1. Beinpaares" was furnished "mit Haken".

According to my own observations this hook belongs to the second endopodite joint, and is homologous with one of the two distal bristles characteristic of this joint in the female. It may be interesting to note in this connection that the other of these two bristles is also present in the male, but has become transformed into a short spine, which has migrated proximally along the dorsal side of the joint. This view is based on the following consideration. In an early larval stage the second endopodite joint of the males exhibits a decidedly bulged appearance on the dorsal distal margin at the place where the hook later appears. Later on, the smooth, recurving hook appears, and somewhat proximally to this and on the same joint a small, sharp, smooth spine is developed. In a still later stage the hook becomes larger, and the spine also increases in size, and assumes a slightly less regular outline. After this the stage included in the description of the fully mature male follows.

The short spine described above has been overlooked by all previous writers, but was found in all specimens examined by me. This refers not only to the California material, but also to material from Japan Sea and Plymouth, England, as well as the original Lilljeborg collection. That this spine has been overlooked until now is probably due to its glassy transparency. In fact, when it is not silhouetted but rests against the joint, it is practically impossible to detect.

Judging by previously published figures, the hook-like modification of the two bristles of the third endopodite joint of the first limb of the male, as well as of some of the distal bristles on the second and third limbs of this sex, have not been previously discovered. These features are constant. At first sight these bristles give the impression of having been mutilated, but careful observation under an oil immersion lens will insure the recognition of the true structure. It should be noted that this modification is brought about just before sex maturity is attained.

Lovén (1838: 160), as well as Leydig (1860: 248), described the penis as conical. Lilljeborg's (1901: 646) description of this structure is more in harmony with the one given above. His drawing (Pl. LXXXVI, fig. 17) in a manner indicates the presence of an endopodite and an exopodite, but he failed to mention these features. Indeed he described the penis as furrowed distally, instead of divided.

Finally it should be noted that Rammner (1930: 5) mislabeled his figure 12, which is a copy of Lilljeborg's Pl. LXXXVI, fig. 15. This figure refers to *Evadne nordmanni* and not, as stated by Rammner, to *Evadne spinifera.*

*Synonymy: Evadne nordmanni* was the first marine cladocer to be named and described. The original description was done so painstakingly by Lovén (1835: 168) that practically no doubt has ever been felt concerning its identity. Whatever uncertainty there has been resulted chiefly from inaccessibility of the original description, to poorly preserved material, inadequate magnification, or lack of attention to detail.

As mentioned in connection with the synonymy of *E. spinifera,* and as may readily be confirmed by a study of the plates of Lilljeborg (1853: 162, tab. 17, fig. 1; tab. 18, fig. 14, 15), we know that the name *E. nordmanni* was used in 1853 to designate the species which was later described by Müller (1868: 225) as *E. spinifera.*

*Geographic Distribution:* The type locality of *Evadne nordmanni* as given by Lovén (1835: 168) is the Cattegat. Numerous workers have reported this species as occurring commonly in this region, as well as extending far in various directions and in widely scattered regions of the world.

Records include: —Cattegat and Swedish Coast, (Lovén, 1835: 168; Stenroos, 1895: 40; Cleve, 1900a: 22, 1902: 23; 1903: 23; Apstein, 1901: 13; Lücke, 1912, Taf. A); —Baltic Sea, (Hensen 1887: 54; Nordquist, 1891: 119–120; Aurivillius, 1898: 121–122, 1899: 35; Hansen, 1899: 10; Apstein, 1901: 41; 1904: 14, 114; 1906, table 1, 2; Driver, 1907: 125 and table; Brock, 1908: 6; Rammner, 1931: 632); —Bay of Bothnia, (Stenroos, 1895: 40; Hansen, 1899: 10); —off Heligoland, Öeresund, and Faerö Channel, (Aurivillius, 1898: 121–2; Levander, 1900a: 14; Lilljeborg, 1901: 642; Gran, 1902: 67–70; International Council, 1908–12: 8–135); —Skagerak, and North Sea (Kiel), (Aurivillius, 1898: 123; 1899: 35; Cleve, 1899b: 16; 1900b: 13; 1902: 12–3; 1903a: 23; Apstein, 1901a: 13; 1904: 110, 114; Rammner, 1931: 632); —from Skagerak along Norwegian coast, and islands nearby, —Barents Sea, and along Murman coast, )Cleve, 1899a: 5; 1899: 9; 1900a: 12; Breitfuss, 1904: 9; Nordgaard, 1905: 48; Gibitz, 1922: 94).

—Coasts of British Isles, (Goodsir, 1842: 366; Cleve 1898: 5; 1900b: 13; 1902: 123; 1903a: 23; Hansen, 1899: 10; Sars, 1900: 47; Herdman, 1911: 75; Lücke, 1911: 14; Farran, 1913: 2).

—Bay of Biscay, (Stebbing, 1904: 52, 54; Gibitz, 1922: 94).

—Mediterranean Sea, and off Naples and Triest, (Schweiger, 1912; Gibitz, 1922: 94).

—In Gulf Stream of North Atlantic, west of the Hebrides, almost half way to Cape Farewell, (Greenland Sea) (Goodsir, 1842: 336; Aurivillius, 1898: 121–2; Hansen, 1899: 10, 13; Cleve, 1901a: 35; Scott, 1906: 46–54); —Labrador Stream off New Foundland to about 50° N. lat., (Apstein, 1901: 13; Hansen, 1899: 10, 13, tab. 4; Hensen, 1911: 324–325). —Other regions along East Coast of North America, (Gibitz, 1922: 94); —Narragansett Bay, Long Island Sound, Woods Hole, New

England coast, (Williams, 1907: 70, 79; U. S. Bureau of Fisheries, 1911: 409, 435; Fish, 1925: 139–140); —Gulf of St. Lawrence, and Nova Scotia, (Kindle and Whittaker, 1918: 248). It might be added that Hansen (1899: 10) suggested that there may have been a specimen of *E. nordmanni* in a haul from the Sargasso Sea region, but due to imperfect preservation it was not possible to be certain.

—Gulf of Guinea, and south along west coast of Cape Cross, Great Fish Bay and southern coast (Capetown) of Africa, (Hansen, 1899: 10; Gibitz, 1922: 95; Rammner, 1931: 620–621, 632); —False Bay (Apstein, 1901: 13).

—East and southern coasts of Japan (Gibitz, 1922: 95; Rammner, 1931: 620–621, 632.

—West coast of North America at Grantley Harbor, Port Clarence Bay, and at 68° 31′ N. Lat., 166° 32′ W. Long., Alaska (Juday, 1920:18), and —"at various places off the coast of Vancouver Island" (Hart and Wailes, 1932: 347, 251).

See also previous paragraph "*Present Material*".

*Seasonal Occurrence: Evadne nordmanni* appears to have the most extended seasonal occurrence of the Cladocera considered in this report. A similar opinion was expressed by Fish (1925: 139), in discussing the occurrence of these forms on the eastern coast of North America.

Aurivillius (1898: 121) stated that the appearance of *E. nordmanni* in Skagerak extended from: "Mitte April bis Ende Februar (jedoch im Jan.–Febr. selten)." Kajdiž (1912: 916–18, 929–930) reported this species as occurring in the months of April, May, and June, "or 1 Exemplar trat allerdings schon im Jänner auf," and gave a summary statement for the Baltic Sea saying that in the "Ostsee schwärmt *E. nordmanni* von April bis Dezember". Fish (1925: 139–140) mentioned that *E. nordmanni* appeared soon after May 20, and disappeared about January 20. This species occurred during each month of the year in Monterey Bay. Its greatest frequency came in the early part of May; relatively few specimens occurred during the winter months. Considering the scarcity of this species in March, as recorded in the literature on distribution, it is rather singular to note that there was a comparatively high frequency in the samples taken during this month in Monterey Bay.

Males occur much less frequently than the females. Lovén (1838: 162) recorded males from June and July; Lilljeborg (1901: 647) from September. In Monterey Bay males were found to occur from the last part of February until November. Due to scarcity of observations, no generalizations can as yet be made in regard to the seasonal occurrence of this sex.

*Temperature:* Cleve (1901a: 35) gave the following thermal records: "9.17°, mean of 8 obs., max. 12.8°, min. 8° (only such samples as considered this species abundantly)". In summing up the data from various records, Rammner (1930: 13) stated that: "*Evadne nordmanni* ist am häufigsten zwischen 6° und 18° (Grenzwerte 1° und 22.6°); diese Art ist eine kosmopolitische, neritische Oberflächenform." The temperature range for Monterey Bay region was from

10°–16° C.; the most usual range is 12°–14° C., that for southern California, 15.5°–18.5° C.

*Salinity:* It has long been recognized that the variation in the salinity under which this form lives is extreme. In his survey Cleve (1901a: 35) gave the salinity as "34.49, mean of 7 obs., max. 35.47, min. 31.83". In a summarizing statement Rammner (1930: 13) said that: "*Evadne nordmanni* wird am häufigsten bei einem Salzgehalt von 2 bis 35‰ angetroffen (Grenzwerte 1.33 und 35.4‰)". It is thus clear that, although *E. nordmanni* can withstand great extremes in salinity, it has not been found in the highest salinities recorded for some of the Cladocera.

## **Evadne spinifera** Müller

Plate 31

***Evadne nordmanni*** Lilljeborg, 1853 (part.): 162–4 (non *E. n* Lovén).

***Evadne mediterranea*** Claus, 1862 (part.) (?): 245; Claus, 1877: 142, note 1.

***Evadne spinifera*** Müller, 1868: 225; De Guerne, 1887: 355, note 1; Sars, 1890: 53; Hansen, 1899: 11; Lilljeborg, 1901: 647–648; Apstein, 1901: 13; Apstein, 1911: 18–19; Behning, 1912: 10; Schweiger, 1912: 9–11; Kajdiz, 1912: 924–929; Gibitz, 1922: 90, 93–94; Rammner, 1930: 5.

***Evadne spinosa*** Krämer, 1894: 222.

*Diagnosis:* Bristle formula of exopodites of thoracic limbs 2–2–2–1. Elevator muscles of second antenna diverge dorsally.

*Description:* Female —

*Size:* Gross length including apical spine 0.70–1.40 mm.; maximum morphological length in California coast specimens 0.51 mm.

*Color:* Slightly creamish, or with a pearly whitish tint.

*Dorsal Pouch Wall:* Clearly transparent.

*Elevator muscles:* Diverge dorsally, forming an angle of about 20°.

The following description refers exclusively to mature specimens.

*Body Outline:* (Pl. 31, figs. 7–8: Brood pouch variable in shape. Anterior margin usually broadly and subuniformly convex, but may be gently and unevenly undulating, particularly after emergence of young. Postmargin may be gently and subuniformly convex, but is often more or less sigmoid, convex ventrally. Dorsal margin more or less narrowly rounded; with strong spine, often somewhat longer than nuchal gland.

*Labrum* (Pl. 31, fig. 1): Elongated, oval with antero-ventral margin obliquely and somewhat rounded truncate; antero-dorsal margin longest in genus. Spines very numerous and arranged in distinct and somewhat transverse groups; most of them short and delicate.

*Second Antenna:* Length greatest in genus; total length about 6 times the morphological length of the body. Protopodite longest in genus, when compared with length of rami, its length somewhat more than twice its width. Penultimate joint of each ramus about 1.8–2.0 times longer than respective distal joints. Plumose bristles of endopodite subequal in length, except the proximal, which is somewhat longer than the remaining ones. Among plumose bristles of exopodite the proximal is about 0.5 the length of the remaining ones, which are subequal. Small bristle dorsal near tips of distal joint of each ramus, about 0.5 the length of respective joint, or slightly less. The conical base of the proximal dorsal spine of the protopodite is about equal in length to the styliform tip.

*Mandibles* (Pl. 31, fig. 2): Right and left members strikingly similar. Comparatively elongate and slender, as also are the major distal teeth; ratio between length and width distal to the pronounced angle, at least 3:1. The dorsal major tooth is about 0.66 the length of the ventral; simple, smoothly conical, and uniformly tapering into a somewhat blunt tip; its length slightly less than twice its basal width. At base of this tooth, and set slightly ventro-laterally, is another smooth tooth, approximately equilateral in outline and about 0.33 the length of the dorsal major tooth. The ventral major tooth is deeply incised into two slender bifurcations, separated by a narrowly rounded notch. The dorsal bifurcation is again divided at tip into 2 unusually sharp points. The ventral bifurcation is a trifle longer, and carries distally 2 denticulated points; at ventral base of this bifurcation are a few, short, slender, sharp bristles. In the middle of lateral side of ventral major tooth there is a minute, roundish, toothlike prominence.

*First Limb* (Pl. 31, fig. 3): First protopodite joint 0.8–0.9 as broad as long. Second protopodite joint about 0.7 the length of the first, and of about equal width. Endite extremely rudimentary, merely a slight knob set with 1–2 slender, sharp spines. Length of exopodite approximately 2 times the width, and about 0.75 the length of first endopodite joint. First endopodite joint averages in width about 0.6 its length, its width is nearly 0.5 the width of first protopodite joint. The 2 distal endopodite joints of about equal length, and about twice wider than long; their total length averages about 0.3 that of second protopodite joint.

There is a number of rather weak spines arranged in pairs on ventral surface of second protopodite joint; the paired arrangement appears characteristic. Exopodite furnished with 2 long, well-developed, flexible bristles, which are strikingly similar in structure and size; their lengths subequal, approximately 2.4 the length of endopodite. Spines on ventral surface of exopodite strikingly well-developed; they progressively decrease in length toward distal end of ramus, the most proximal ones being about 4 times the length of the most distal; the most proximal at least 2 times the length of corresponding spines in other members of the genus. The 4 bristles on the ventral margin of first endopodite joint have a serial arrangement, the distance between the bases growing progressively greater distally as the length and strength of the bristles also increase somewhat. The most distal of these bristles about 0.4 the length of the dorsal exopodite bristle; most proximal bristle about 0.4 the length of the most distal. The bristle of the second endopodite joint about as well-developed as the dorsal bristle of exopodite, but only about 0.66 as long. The 2 distal bristles of third endopodite joint subequal in length to those of exopodite but slightly stronger proximally.

*Second Limb* (Pl. 31, fig. 4): Approximately equal in length to first limb. Protopodite joints of same proportions and size as corresponding joints of first limb. Endite about as long as first endopodite joint, gradually narrowing distally. Exopodite of the same proportions, but only 0.66 as long as that of the first limb. Endopodite about as in first limb, but its first joint is somewhat broader.

Distal margin of the endite set with 2 powerful, conical, sharp, spine-like, smooth teeth, diverging at about 30° angles. Of the 2 distal bristles of exopodite, the ventral is weaker than, and about 0.66 the length of, the dorsal, which is about 0.6 the length of the dorsal bristles of exopodite of first limb. Bristles of first endopodite joint strikingly similar in size and structure to those of the corresponding joint of first limb. The ventral of the 2 bristles on second endopodite joint less well-developed, and 0.7 the length of the dorsal; the latter approximates in length bristles of third endopodite joint. The 2 bristles of third endopodite joint are as well-developed as those of corresponding joint of first limb, but only 0.6 their length.

*Third Limb* (Pl. 31, fig. 5): Slightly shorter than second limb. Protopodite joints nearly of the same relative proportions as in this limb, yet almost imperceptibly smaller. Endite fairly closely approximates that of second limb in size and proportions. Exopodite of about the same width as, but only about 0.75 the length of, that of second limb. Width of first endopodite joint about 0.7–0.8 the length; this joint approximately 0.7–0.8 the length of corresponding joint of second limb. Second endopodite joint similar in length and proportions to that of second limb. Third endopodite joint similar to this joint of second limb, although slightly shorter.

Armature of spines of endite closely similar to that of second limb. Exopodite with 2 bristles, the ventral one of which is about 0.5 the length of the dorsal, which is about 0.7 the length of the dorsal bristle of exopodite of second limb. First endopodite joint with 3 ventral bristles, the 2 distal ones fairly near distal margin, the remaining ones somewhat proximal to middle of joint; all 3 slightly shorter, yet about equal in development to the 3 most proximal of the corresponding bristles of second limb. Bristles of the second and third endopodite joints similar in arrangement and development to the corresponding ones of the second limb, but only 0.7–0.8 their lengths.

*Fourth Limb* (Pl. 31, fig. 6): About 0.4 the length of the first limb. First protopodite joint slightly less than 0.5 as long as broad. Second protopodite joint about 0.7–0.8 as broad as long; its width is slightly less than that of first protopodite joint, and about 0.7 the corresponding width of first limb. Endite (?) is represented by at least one fairly short, sturdy spine, slightly more robust than in *E. nordmanni* Lovén, and less so than in *E. tergestina* Claus. Exopodite slightly more than 0.25 the length of second protopodite joint, and tapers very strongly from a comparatively broad base. It has a nearly straight distal bristle, the length of which is slightly less than length of this limb, and about 0.4 the dorsal bristle of exopodite of first limb.

Endopodite of about the same length as exopodite and about 0.5 as long as broad, with 4 bristles; 3 of these are subequal and about 0.4 the length of exopodite bristle; the remaining, most ventral one, is about 0.33 shorter.

*Abdomen:* Bifurcations slightly longer, and little, if at all, narrower than in other members of genus; closely approximating that of *E. tergestina* Claus; tips of caudal somewhat more curved than in other species of genus, and usually directed posteriorly. The 2 caudal setae, long and extremely fragile.

*Description:* Male —

Since no specimens were seen by the writer, reference is made for diagnosis and description to Lilljeborg (1901: 649, Pl. LXXXVII, figs. 2, 3); Apstein (1911: 18–9, fig. 29 (from Lilljeborg 1901); Rammner (1930: 5, fig. 10). It should be noted that Rammner's fig. 10 should read *E. spinifera*, instead of *E. nordmanni.* This figure is copied from Lilljeborg's monograph (Pl. LXXXVII, fig. 2).

*Present Material:* The above data are derived largely from material from the following localities: —Baltic Sea, off coast of Sweden, in vicinity of Skelderviken: 56° 15′ N. Lat., Aug. 10, 1880; No. 2716, Lilljeborg collection. —Three stations off coast of southern California: —31° 31′ N. Lat., 119° 57′ W. Long., 50 m. to surface, Feb. 18, 1931; —43° 55′ N. Lat., 122° 00′ W. Long., 40 m. to surface, June 17, 1930; —34° 05′ N. Lat., 119° 28′ W. Long., surface, June 28, 1930.

*Comparison with previous Descriptions:* Aside from some obvious omissions and errors in previously published descriptions and figures, the results of my morphological analysis of this species are well in agreement with these data. Various maximum gross lengths of the females of this species are recorded. Müller (1868: 266) gives 0.4 mm.–0.8 mm.; Lilljeborg (1901: 647), 1.34 mm.; and Rammner (1930: 5), 0.70–1.40 mm. The specimens off the coast of southern California reached 1.26 mm. Considerable variation in the maximum length may thus be noted from region to region. There are no records of the morphological length available in the literature for comparison.

*Synonymy:* The synonymy of *Evadne spinifera* is comparatively clear from the beginning. The first figures seem to be those by Lilljeborg (1853: Pl. 17, fig. 1; Pl. 18, fig. 14, 15). However, the species was not recognized as distinct until the work of Müller (1868: 225). There seems to be a possibility that Claus (1862: 245) may have mentioned and described *E. spinifera* as *E. mediterranea* (De Guerne, 1887: 355, note 1), but Claus (1877: 140, 142 note 1) fails to acknowledge this. In connection with material from Jervis Bay the name *E. spinosa* slipped into the literature (Krämer 1894: 222), presumably in place of *E. spinifera*, but through the correction, soon after, by Hansen (1899: 11) practically no confusion has resulted.

*Geographic Distribution: Evadne spinifera*, described originally from "Hellebaek" (Müller, 1868: 225), is widely distributed in the various oceans, predominantly, but not exclusively, in the warmer regions.

It has been found scatteringly in the general region of the type locality, but most commonly in warmer waters. Lists include the following: —Baltic Sea and North Sea (Sars, 1890: 53; Aurivillius, 1898: 44; Cleve, 1899a: 9; 1900a: 12, 40, 42; 1902: 3; Hansen, 1899: 10–11; Apstein, 1904: 107, 110, 114; 1910: 10; Driver, 1907: 125 and tab.; Rammner, 1931: 620, 632); —Cattegat, Oerosund, and Skagerak (Aurivillius, 1898: 4; Cleve, 1900b: 13; 1902: 23; 1903: 23; Apstein, 1901: 13; International Council 1908–12: 57–135); —Coast of Norway. (Apstein, 1901: 13); —Barents Sea and off Murman Coast (Breitfuss, 1904: 9).

—Off coast of British Isles (Hansen, 1899: 11; Cleve, 1900a: 12; 1903: 23; Apstein, 1901: 13; Herdmann and Scott, 1908: 261–262).

In a survey of the North Atlantic and some of the bordering waters Gibitz (1922: 93) says that *E. spinifera* extends: "von der Beltsee durch Kattegat and Skagerak sowie Nordsee bis zu den Faeröer. Von da geht die Nordgrenze ihres Verbreitungsgebietes durch den atlantischen Ozean bis etwa Nova Scotia and der nordamerikanischen Küste."

—Along the east coast of North America, along New Brunswick (MacDonald, 1912: 83), and Nova Scotia (Kindle and Whittaker, 1918: 248); —in North Equatorial Stream of Atlantic Ocean; —Sargasso Sea; almost all the way from Bermuda Islands to the Cape Verde Islands: somewhat south from the later islands; —off the Azores, and at a station far to the north-east of these, at about same latitude as the northern coast of Spain; —and at different places in Brazil Stream, including 23° 8′ S. Lat., 39° 40′ W. Long., and 25° 29′ S. Lat., 36° 21′ W. Long. (Hansen, 1899: 10–13, tab. 4; Cleve, 1901a: 36; 1900b: 13; Hensen, 1911: 324; Scott, 1912: 580; Rammner, 1931: 632).

—Along the European coasts, in Bay of Biscay (Stebbing, 1904: 52); —at 36° N. Lat., 6° W. Long. (Cleve, 1903b: 369); —Naples (Apstein, 1901: 13); —numerous stations in the Adriatic Sea (Schweiger, 1912: 9–10); —Mediterranean Sea near Messina and Triest (Hansen, 1899: 10–11; Graeffe, 1900: 1; Kajdiz, 1912: 916–919); at 37° N. Lat., 2°–10° E. Long. (Cleve, 1903b: 370); and in "süssen und brackischen Gewässern Dalmatiens" (Car, 1902: 602). It might be noted here that Markaroff (1928: 204–205), in a list of Cladocera from the Ingul River, reports *E.* (*spinifêra*): "man muss besonders das Vorkommen der *Evadne* (*spinifêra*) betonen, welche Form bisher nur aus dem Meer bekannt ist. Die erwähnte Form wurde in Flusse Ingul unweit von der Mündung dieses Flusses in Bug entdeckt."

—Additional records include northwest, west and south coasts of Africa, Gulf of Guinea, Great Fish Bay and Cape Town (Apstein, 1901: 13; Rammner, 1931: 620–621, 632).

—Central Indian Ocean (Apstein, 1901: 13; Rammner, 1931: 621). Incidentally, Apstein recorded "Indischer Ozean 27–30° N. Br., 87–91° Ö. L.," but must have meant 27°–30° S. Lat., instead of North. In connection with the Valdivia Expedition he spoke of the region as "87°–90° Ö. and 16°–31° S" (Gibitz, 1922: 94).

—Off southwestern and southeastern coasts of Australia (Hansen, 1899: 11; Gibitz, 1922: 93; Rammner, 1931: 621), —Jervis Bay, Sidney (Krämer, 1894: 222); —and south and east coast of Japan (Rammner, 1931: 623).

See also previous paragraph "Present Material".

*Seasonal Occurrences:* This species is recorded from the Cattegat as early as February, and has been observed from March until the last of December in the Adriatic Sea (Kajdiž, 1912: 916–919, 925–929). The period of occurrence is apparently somewhat curtailed in northern regions. The summary by Kajdiž is in general in keeping with results of various workers in the field. Here it is stated that: "Die Schwärmzeit von *E. spinifera* ist bei uns um 4 Monate länger als in Norden, ihr Auftreten um 1 Monat früher und ihr Verschwinden um 3 Monate später; die Hauptzeit ihrer Entwicklung erstreckt sich bei uns ungefähr auf 3 Monate, ist im Norden auf 1 Monat beschränkt; der Kulminationspunkt wird bei uns ungefähr einen Monat früher erreicht als im Norden (Triester Golf: Mitte Juli; Norden: August)".

In my very limited material from the southern California coast *E. spinifera* appeared in February and June. This indicated that in these waters the species has a period of occurrence at least as extended as the one established for the specimens from the Adriatic Sea. In all probability it may occur throughout the entire year.

*Temperature:* As summed up by Cleve (1901a: 36) the temperature range for this species was, "20.7, mean of 35 obs., max. 25, min. 10.7." A brief, yet comprehensive summary by Rammner (1930: 13) is to the effect that: "*Evadne spinifera* zeigt Vorliebe für wärmeres Wasser, ist am häufigsten zwischen 14° und 18° und kommt im Normeer zwischen 2.99° und 18° vor. . . . sie findet sich in den wärmeren Teilen aller Weltmeere als thermophile Oberflächenform."

Temperature range for present material was 15.7°–18.5° C.

*Salinity:* Cleve (1901a: 36) summed up the salinity as "35.39, mean 26 obs., max. 37.31, min. 30.60". Of the salinity Rammner (1930: 13) remarked that "*Evadne spinifera* kommt im Nordmeer bei einem Salzgehalt von 8.55 bis 35‰ vor, im Sargassum bei 27‰". It has been reported (Marapob, 1928: 205) rather uncertainly that this species has been found in fresh water, as quoted above. This would indicate a salinity hardly comparable with any recorded for any of the principally marine species. Until this record has been checked too much reliance should not be placed on this statement.

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## PLATE 26

*Podon polyphemoides* (Leuckart)

Fig. 1. Second antenna. × 107.

Fig. 2. First antennae. × 173.

Fig. 3. Mandible. × 148.

Fig. 4. Labrum. × 173.

Fig. 5. Mandible. × 148.

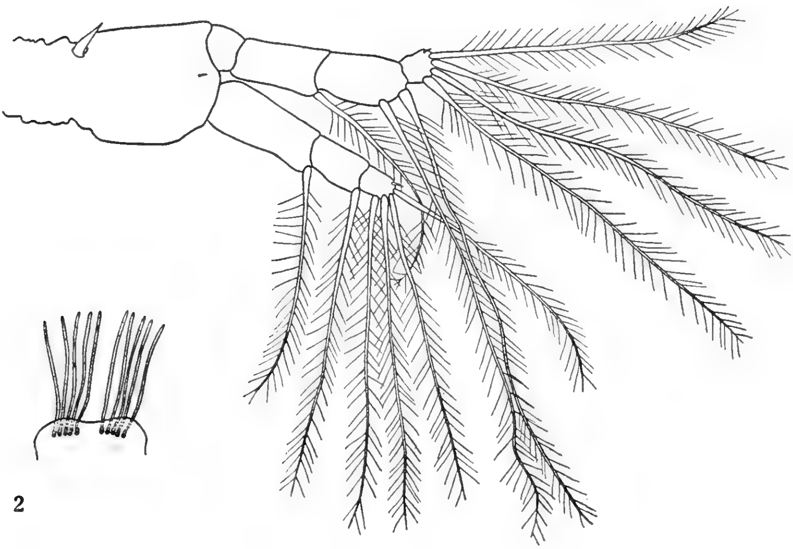
Fig. 6. Female with well-developed embryos. × 18.

Fig. 7. Female after emergence of the young, with newly formed eggs. × 18.

Fig. 8. Mature male. × 18.

Fig. 9. Female shortly after emergence. × 27.

All figures are of right lateral view except Fig. 2, which is anterior, and Fig. 3, left medial.



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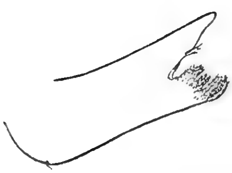

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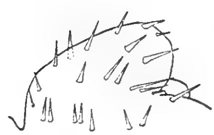

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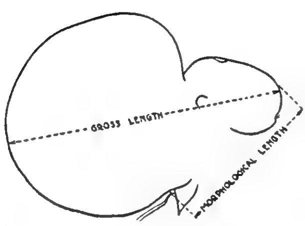


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## PLATE 27

*Podon polyphemoides* (Leuckart)

Fig. 1. First thoracic limb. × 107.

Fig. 2. Second thoracic limb. × 107.

Fig. 3. Third thoracic limb. × 107.

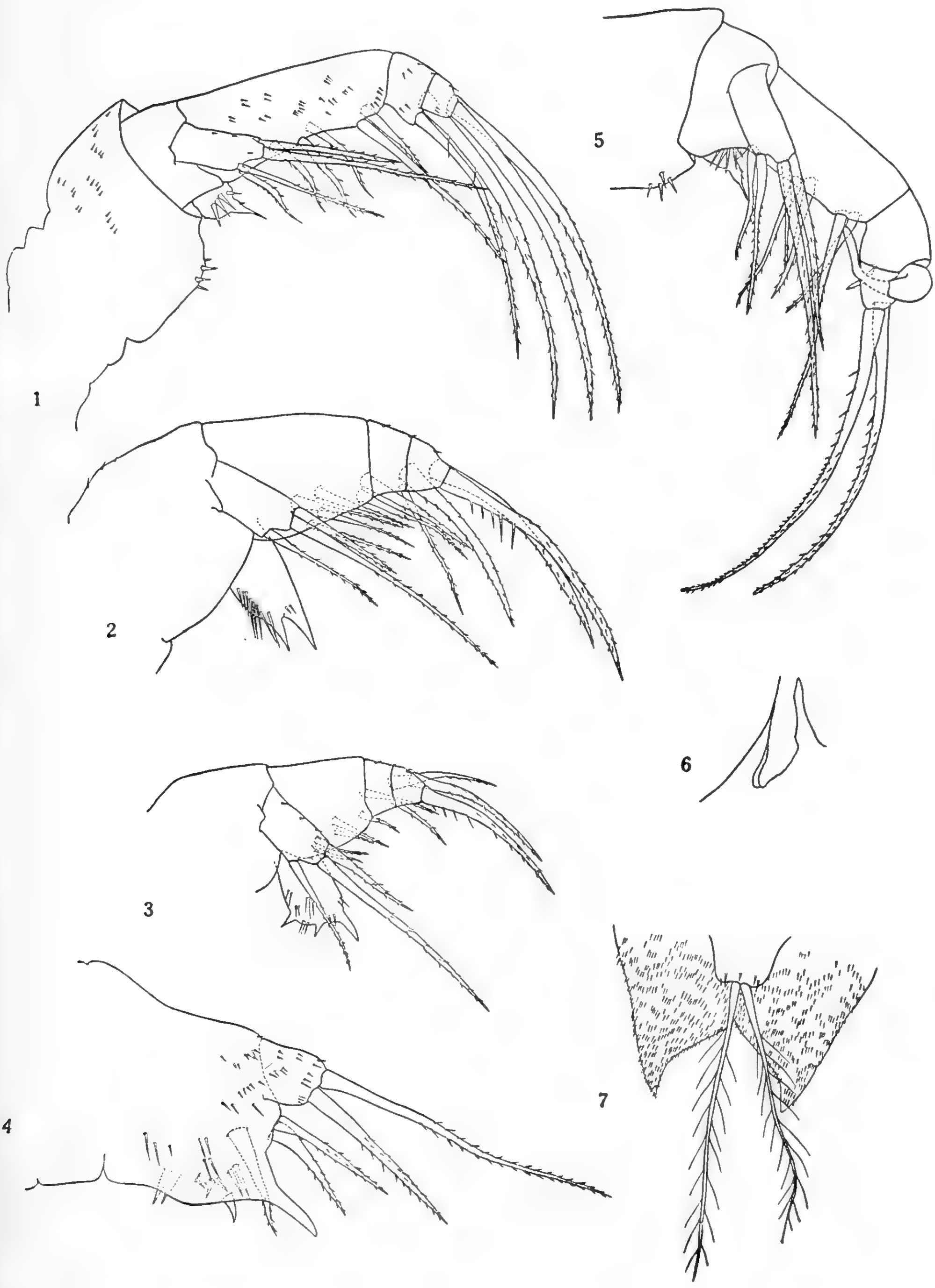
Fig. 4. Fourth thoracic limb. × 107.

Fig. 5. First thoracic limb, male. × 107.

Fig. 6. Penis, male. × 173.

Fig. 7. Caudal furca with bristles. × 173.

All figures are in right lateral view except Fig. 4, which is right ventrolateral, and Fig. 7, dorsal.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## PLATE 28

*Evadne tergestina* Claus

Fig. 1. Female with well-developed embryo. × 18.

Fig. 2. Female after emergence of the young, with newly formed eggs. × 18.

Fig. 3. Left mandible. × 173.

Fig. 4. Labrum. × 173.

Fig. 5. Mandible. × 173.

Fig. 6. First thoracic limb. ×107.

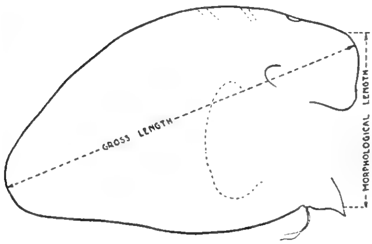
Fig. 7. Second thoracic limb. × 107.

Fig. 8. Third thoracic limb. × 107.

Fig. 9. Fourth thoracic limb. × 107.

Fig. 10. Caudal furca and bristles. × 107.

All figures are of right lateral view except Fig. 3, which is left lateral, Fig. 9, oblique lateral, and Fig. 10, dorsal.

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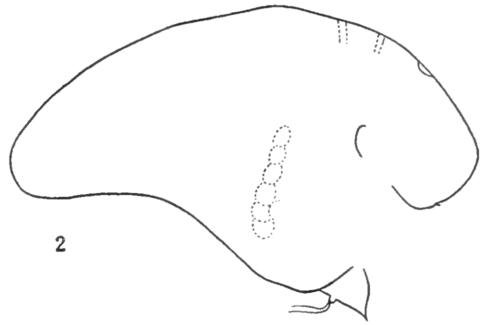

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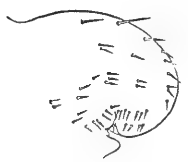

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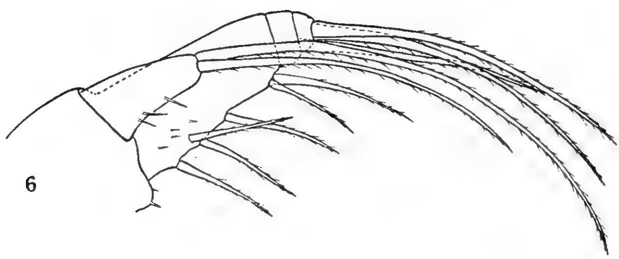

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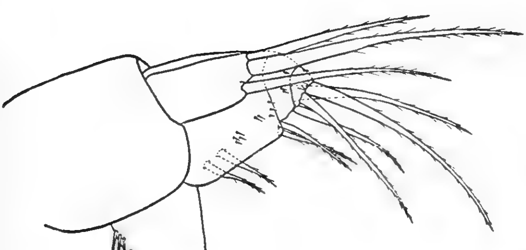

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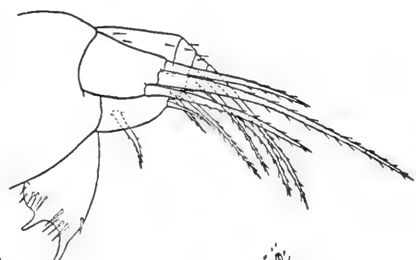

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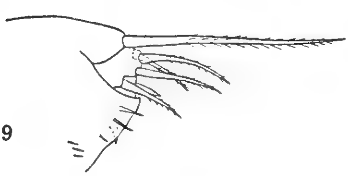

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## Plate 29

*Evadne nordmanni* Lovén

Fig. 1. Second antenna. × 95.6.

Fig. 2. First antennae. × 133.

Fig. 3. Mandible. × 133.

Fig. 4. Labrum. × 133.

Fig. 5. Mandible. × 133.

Fig. 6. Female with well-developed embryos. × 16.4.

Fig. 7. Female after emergence of the young, with newly formed eggs. × 16.4.

Fig. 8. Mature male. × 16.4.

Fig. 9. Female, shortly after emergence. × 24.

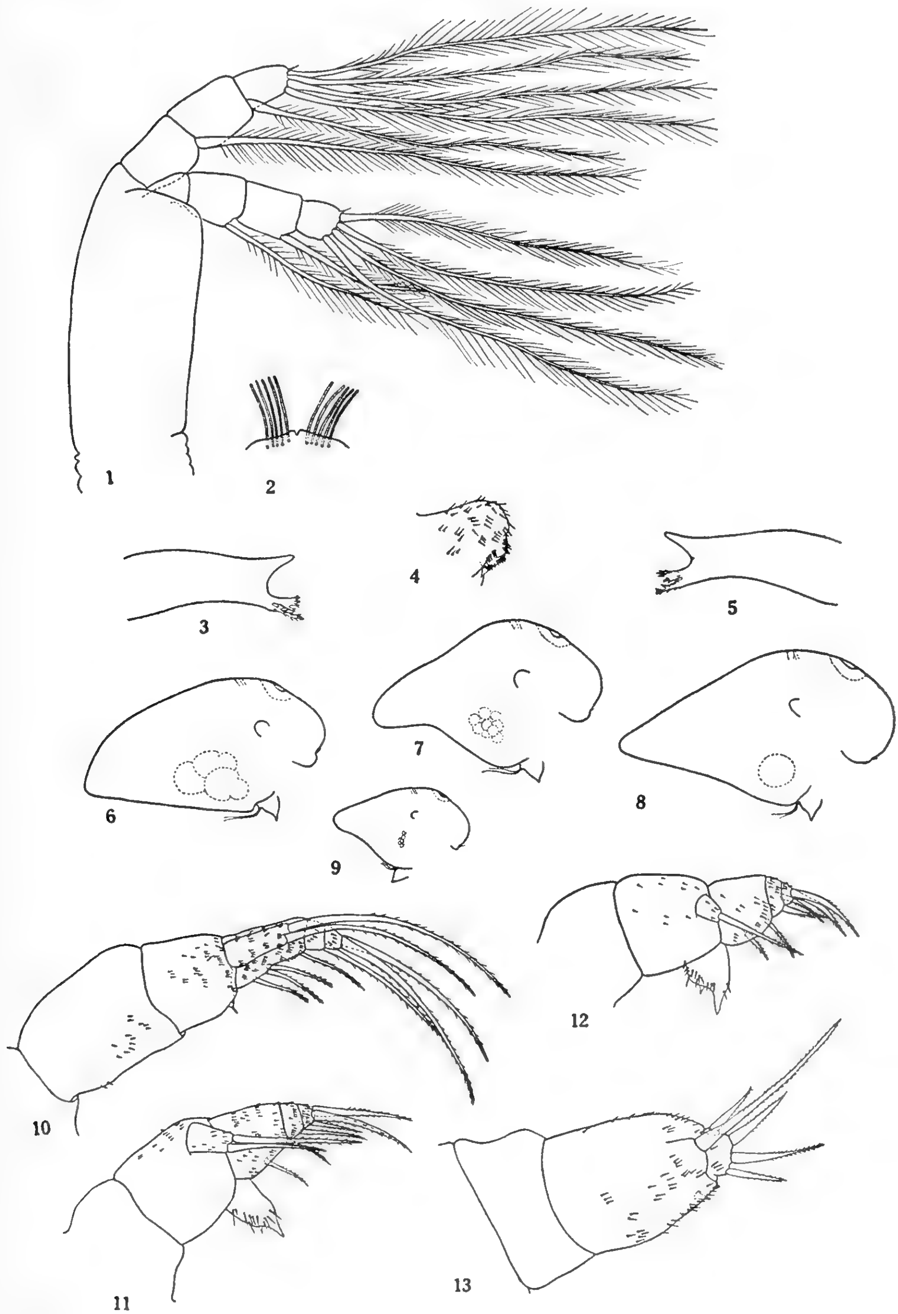
Fig. 10. First thoracic limb. × 76.

Fig. 11. Second thoracic limb. × 76.

Fig. 12. Third thoracic limb. × 76.

Fig. 13. Fourth thoracic limb. × 133.

All figures are of right lateral view except Fig. 2 which is anterior, and Fig. 3, left medial.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## PLATE 30

*Evadne nordmanni* Lovén

Fig. 1. First thoracic limb, male. × 107.

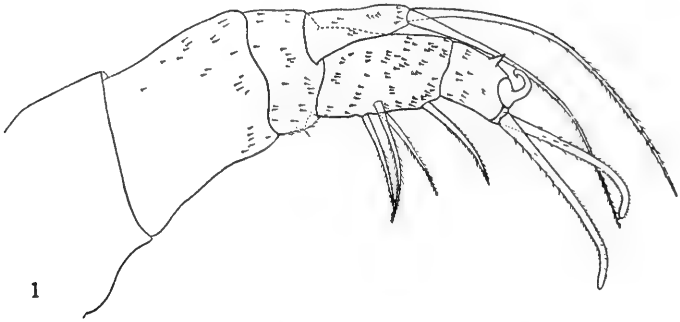
Fig. 2. Second thoracic limb, male. × 148.

Fig. 3. Third thoracic limb, male. × 148.

Fig. 4. Tip of caudal furca and penis, male. × 173.

Fig. 5. Caudal furca with bristles. × 173.

All figures are of right lateral view.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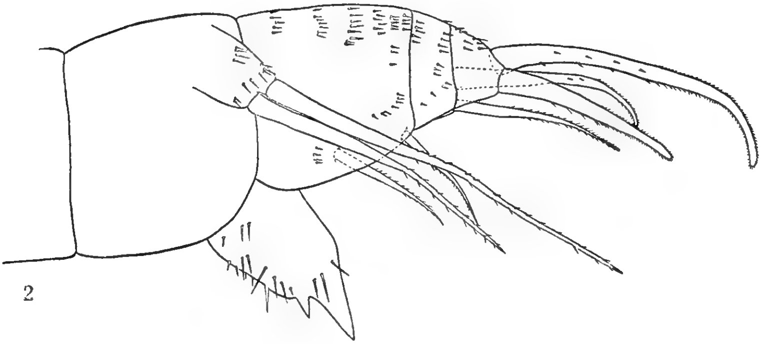
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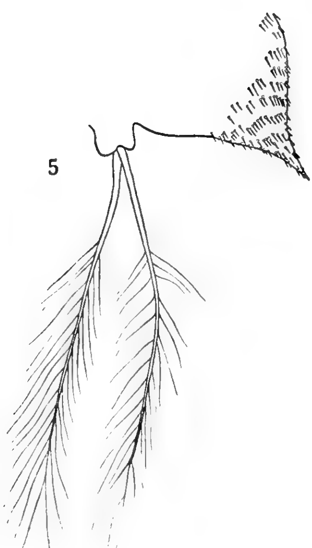
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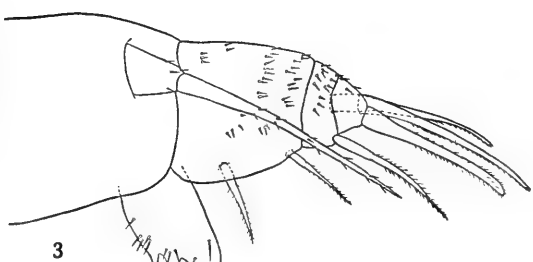
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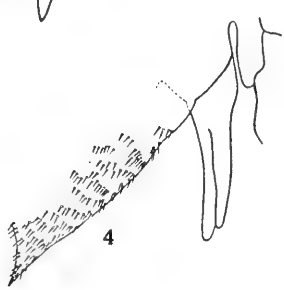
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PLATE 31

*Evadne spinifera* Müller

Fig. 1. Labrum. × 155.

Fig. 2. Mandible. × 155.

Fig. 3. First thoracic limb. × 95.6.

Fig. 4. Second thoracic limb. × 95.6.

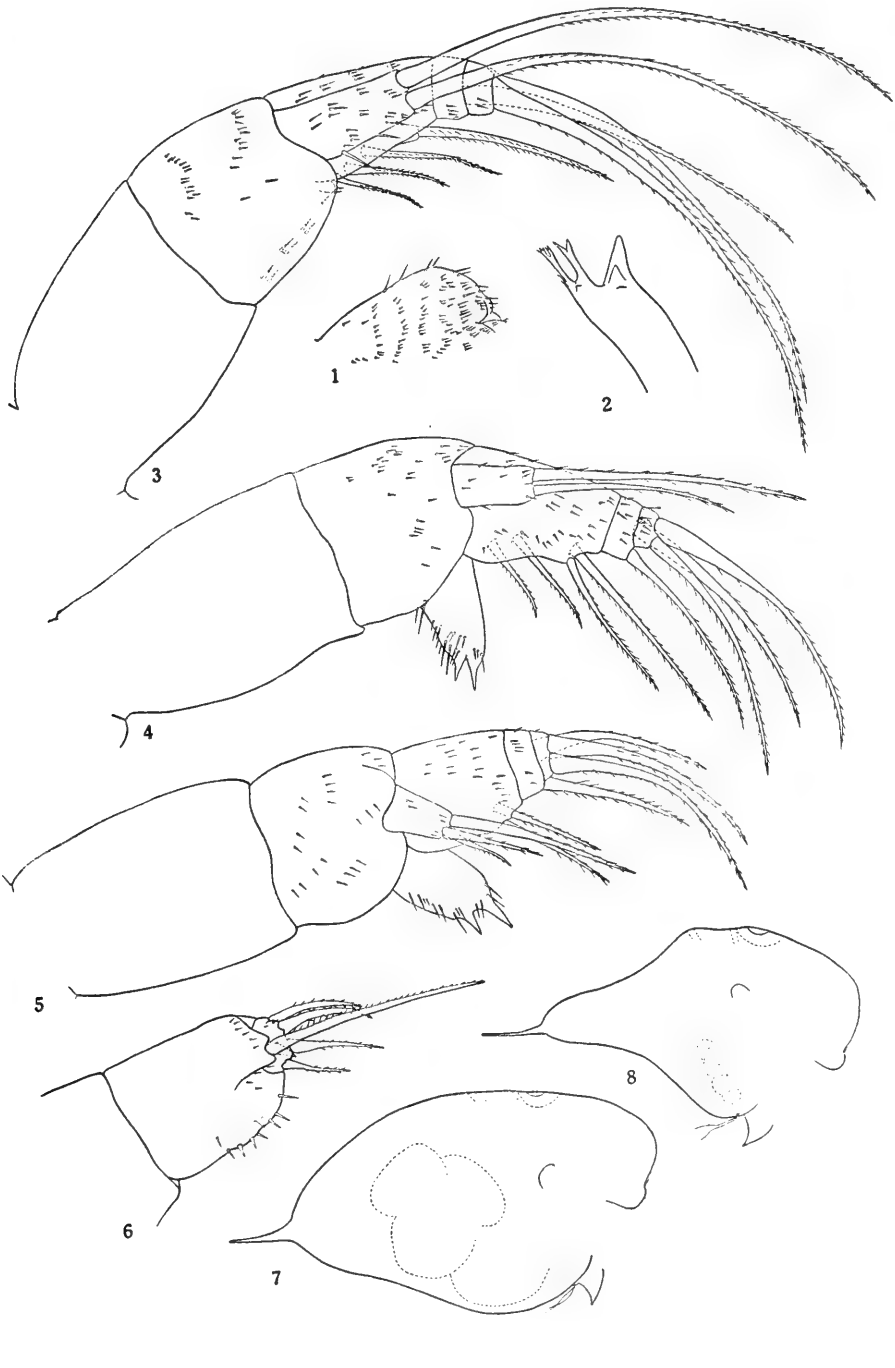
Fig. 5. Third thoracic limb. × 95.6.

Fig. 6. Fourth thoracic limb. × 95.6.

Fig. 7. Female with well-developed embryos. × 16.4.

Fig. 8. Female after emergence of the young, with newly formed eggs. × 16.4.

All figures are of right lateral view except Fig. 2, which is right medial.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**PROCEEDINGS**

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## No. 24

# MARINE PLEISTOCENE MOLLUSKS FROM THE GALAPAGOS ISLANDS*

BY

LEO GEORGE HERTLEIN
*Assistant Curator of Paleontology*

AND

A. M. STRONG
*Los Angeles, California*

During the expedition of the California Academy of Sciences to the Galapagos Islands[1] in 1905-1906, Mr. W. H. Ochsner collected some marine mollusks from a raised beach on Albemarle (Isabela) Island, about 12 to 15 meters above sea level. Dall and Ochsner[2] considered these beds to be Pleistocene in age. Smith[3], remarking on the climatic significance of this fauna, stated that no displacement of the isotherms was indicated in comparison to present day conditions.

During the G. Allan Hancock Expedition of the California Academy of Sciences to the Galapagos Islands in 1931-1932, Mr. George Stone, photographer on Captain Hancock's exploration cruiser

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* Printed from the John W. Hendrie Publication Endowment.

[1] J. R. Slevin. Log of the Schooner "Academy" on a Voyage of Scientific Research to the Galapagos Islands, 1905-1906. Occ. Pap. Calif. Acad. Sci., No. 17, 162 pp., 17 pls., Feb. 14, 1931.

See also: Galapagos Islands. Handbooks prepared under the direction of the Historical Section of the Foreign Office, (London), **22**, no. 140: 60 pp., 1920.—L. W. Chubb, The St. George Scientific Expedition. Geol. Mag., **62**: 369–373, 1925.—L. W. Chubb, Geology of Galapagos, Cocos and Easter Islands. Bernice P. Bishop Mus., Bull. no. 110, 1933, 44 pp., 5 pls. Petrology of the Galapagos Islands by C. Richardson, pp. 45–64. Bibliography, pp. 65–66.

[2] W. H. Dall and W. H. Ochsner. Tertiary and Pleistocene Mollusca from the Galapagos Islands. Proc. Calif. Acad. Sci., (4), **17**, no. 4: 89–185, pls. 2–7, 5 text figs., June 22, 1928. See especially pp. 91–92, 96–97.

[3] J. P. Smith, Proc. Calif. Acad. Sci., (4), **9**, no. 4: 135, 1919.

*Velero III*, called the attention of the senior author to a raised beach at James Bay on James (San Salvador) Island. This ancient strand line extends along the coast for possibly a kilometer, at an elevation of about five to ten meters. Where not hidden by later lava flows this raised beach is on a lava platform which is covered by a thin veneer, or, in places, pockets of sand, fine sediment and some scattered boulders. A collection was made of the fossil marine shells which occur scattered about.

A study of the fossils of this beach leads to many interesting considerations. The Galapagos Islands lie on the equator about 960 kilometers (600 miles) west of Ecuador. On the lower slopes the islands are dry and warm, but the cool Humboldt current which sweeps up from the Peruvian coast, makes the climate along the shores unusually cool despite their equatorial position. A comparison of the fossil mollusks with those of the present known Galapagan fauna, and with those of the adjacent mainland, casts some light on the origin of the islands and the derivation of the fauna.

Dall and Ochsner regarded many of the Pliocene and Pleistocene mollusks to be related to those of the Panamic province, and the Gulf of California, and some affinities were noticed with the Caribbean region. With this conclusion the present writers are in accord.

Pilsbry[4] pointed out that the land snails are essentially Central American and Mexican in affinities. Furthermore the basaltic rocks of the Galapagos Islands are essentially Central and North American types. A study of the birds of the Galapagos Islands convinced Swarth[5] of the Caribbean affinities of much of the avifauna. A map by Dacqué[6] showing the trend of the Tertiary mountain ranges in the Central American region is very illuminating in regard to this study. The Tertiary mountain axes formed a bend to the east, thus including, west of the main mountain chain, a considerable portion of the present Caribbean region. Faunal evidence indicates that the Central American land barrier was open, at least during a part of the Miocene.

A small faunule was collected by the senior author from hard sand-

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[4] H. A. Pilsbry. Notes on the Galapagos, pp. 117–122, in "To the South Seas," by Gifford Pinchot, Philadelphia, 1930, (John C. Winston Co.).

[5] H. S. Swarth. The Avifauna of the Galapagos Islands. Occ. Papers Calif. Acad. Sci., No. 18, 1931, pp. 1–299, 1 pl. (map), 57 text figs. — The Bird fauna of the Galapagos Islands in relation to species formation. Biol. Reviews, **9**, 2: 213–234, 3 figs., April, 1934. — See also, A. Gulick, Quart. Rev. Biol., **7**, no. 4: 416–417, 1932.

[6] E. Dacqué. Grundlagen und Methoden der Paläogeographie. Jena, 1915. [See map.]

See also Charles Schuchert, Historical Geology of the Antillean-Caribbean Region. New York, 1935, (John Wiley and Sons.), I-XXVI, pp. 1–811. 16 pls. (Paleogeographic Maps); 107 figs., 1 frontispiece.

Lecointre (Mem. Soc. Sci. Nat. Maroc., No. 14: 86–90, 134–135, 1926), has recorded the occurrence of "*Calyptraea* (*Trochatella*) *trochiformis* Gmelin" and "*Purpura* (*Acanthina*) *crassilabrum* Lamarck" in the Marine Quaternary of Anfa, Morocco. These are known Recent off Chile and Peru and the former is recorded by Lecointre from the Cape Verde Islands off Western Africa. He suggested that these species might have made their way around Cape Horn when conditions were warmer than at present, and then reached western Africa by following a landmass or a chain of islands or by attachment to floating objects.

Assuming the identity of the Chilian and African species, there appears as yet no evidence of any considerable migration of species between these two regions, during any late geologic period.

stone beds, at sea level on South Seymour Island. The species from that locality are all living in the waters about the Galapagos Islands. Mr. J. R. Slevin, in 1927, during the voyage of Captain G. Allan Hancock's ship, *Oaxaca*, collected a few species from Albemarle (Isabela) Island in beds reported to be somewhat similar to those just mentioned on South Seymour Island. Two species were collected on the Templeton Crocker Expedition to the Galapagos Islands, from beds exposed on the shore on Jervis (Rabida) Island. The species are all Recent. The shells from all the localities retain color markings, or traces of such markings, in many cases.

The shells from James Bay are assigned to the late Pleistocene. Those from South Seymour and Jervis (Rabida) Island are regarded as probably the same age. Those from Albemarle might perhaps be regarded as late Pleistocene or possibly subfossil.

The writers wish to express their acknowledgments to: Captain G. Allan Hancock, whose generosity made it possible to secure the collection on which this paper is based; to Dr. G. Dallas Hanna, Curator of the Department of Paleontology of the California Academy of Sciences, for the line drawings of *Transennella galapagana* illustrated in the present paper, and for helpful suggestions. Acknowledgment is also due the late Mr. H. S. Swarth, and to Mrs. M. E. Davidson, formerly of the Department of Ornithology of the same institution, for criticism of the manuscript; and to Mr. E. H. Quayle who kindly identified the coral.

Loc. 27255 (C. A. S.). Raised beach 5 to 10 meters above sea level at James Bay, James (San Salvador) Island, Galapagos Islands; L. G. Hertlein, collector; January 11, 1932. Late Pleistocene.

*Astropsammia pedersenii* Verrill
*Antigona isocardia* Verrill
*Antigona multicostata* Sowerby
*Arca (Acar) gradata* Broderip and Sowerby
*Arca (Acar) pusilla* Sowerby
*Arca (Barbatia) reeveana* d'Orbigny
*Arca (Fossularca) solida* Sowerby
*Chama frondosa* Broderip[7]
*Chione undatella* Sowerby
*Codakia galapagana* Dall
*Kellia suborbicularis* Montagu
*Lima pacifica* d'Orbigny
*Lithophaga aristata* Dillwyn
*Mytilus adamsianus* Dunker
*Ostrea fisheri* Dall [juvenile]
*Pecten (Lyropecten) magnificus* Sowerby
*Pedalion chemnitzianum* d'Orbigny
*Semele punctata* Sowerby
*Semele rupium* Sowerby
*Transennella galapagana* Hertlein and Strong, n. sp.
*Venericardia megastropha* Gray (*V. flammea* Michelin)

*Acanthina grande* Gray
*Acanthina muricata* Broderip
*Acmaea* sp.
*Agathotoma* cf. *camarina* Dall
*Alaba supralirata* Carpenter
*Aletes squamigerus* Carpenter
*Alvania lara* Bartsch
*Alvania veleronis* Hertlein and Strong, n. sp.
*Anachis incerta* Stearns
*Anachis* sp.
*Aspella erosa* Broderip
*Aspella pyramidalis* Broderip
*Bullus punctulatus* A. Adams

[7] A specimen of this species was also collected by Mr. H. S. Swarth, at Loc. 27545 (C. A. S.), James Bay. It was attached to lava at an elevation stated to have been about 90 to 100 meters, and perhaps 300 meters inland from the shore, about midway between the "red butte," which is surrounded by lava, and the houses at the north end of James Bay.

*Caducifer thaleia* Pilsbry and Lowe
*Calliostoma* sp.
*Cancellaria haemastoma* Sowerby
*Cantharus sanguinolentus* Duclos
*Cerithiopsis anaitis* Bartsch
*Cerithiopsis curtata* Bartsch
*Cerithium adustum* Kiener
*Cerithium uncinatum* Gmelin
*Cheilea equestris* Linnaeus
*Clathurella trichodes* Dall
*Colubraria lucasensis* Strong and Hertlein
*Conus brunneus* Wood
*Conus nux* Broderip
*Conus purpurascens* Broderip
*Conus tiaratus* Broderip
*Craspedotriton scalariformis* Broderip
*Crepidula aculeata* Gmelin
*Crepidula arenata* Broderip
*Cymatium wiegmanni* Anton
*Cypraea nigropunctata* Gray
*Cypraecassis tenuis* Wood
*Cypraeolina margaritula* Carpenter
*Daphnella* sp.
*Diodora alta* C. B. Adams
*Diodora inaequalis* Sowerby
*Engina reeviana* C. B. Adams
*Epitonium* (*Asperoscala*) cf. *emydoneus* Dall
*Epitonium* sp.
*Erato marginata galapagensis* Schilder
*Fossarus angiostoma* C. B. Adams
*Fossarus atratus* C. B. Adams
*Fossarus* sp.
*Fossarus* sp.
*Gadinia peruviana* Sowerby
*Heliacus* cf. *planispira* Pilsbry and Lowe
*Hipponix barbatus* Sowerby
*Latirus tuberculatus* Broderip
*Latirus varicosus* Reeve
"*Mangelia*" *hancocki* Hertlein and Strong, n. sp.
"*Mangelia*" sp.
*Marginella minor* C. B. Adams
*Melanella falcata* Carpenter
*Melanella* cf. *hastata* Sowerby
*Metaxia convexa* Carpenter
*Microcitharia uncinata* Sowerby
*Mitra funiculata* Reeve
*Mitra* cf. *lens* Wood
*Mitra solitaria* C. B. Adams
*Mitra* (*Strigatella*) *tristis* Broderip
*Mitra* sp.
*Mitrella ocellata* Gmelin
*Modulus cerodes* A. Adams
*Morum tuberculosum* Sowerby
*Muricopsis dubia* Sowerby
*Nassarius versicolor* C. B. Adams
*Odostomia* (*Miralda*) *incantata* Hertlein and Strong, n. sp.
*Odostomia* (*Ividella*) *orariana* Dall and Bartsch
*Odostomia* (*Chrysallida*) *paupercula* C. B. Adams
*Odostomia* sp.
*Olivella gracilis* Broderip and Sowerby
*Pedipes angulatus* C. B. Adams
*Phasianella* (*Tricolia*) *perforata* Philippi
"*Philbertia*" *stonei* Hertlein and Strong, n. sp.
*Phyllonotus princeps* Broderip
*Phyllonotus regius* Wood
*Pleurobranchus* sp.
*Polinices uber* Valenciennes
*Pyrene haemastoma* Sowerby
*Rissoina dina* Bartsch
*Rissoina* cf. *laurae* de Folin
*Rissoina signae* Bartsch
*Seila assimillata* C. B. Adams
*Tectarius galapagiensis* Stearns
*Tegula cooksoni* E. A. Smith
*Tegula snodgrassi* Pilsbry and Vanatta
*Terebra strigata* Sowerby
*Terebra* sp.
*Thais callaoensis* Gray
*Thais crassa* Blainville
*Thais patula* Linnaeus
*Thais planospira* Lamarck
*Triphora alternata* C. B. Adams
*Triphora chathamensis* Bartsch
*Triphora galapagensis* Bartsch
*Triphora inconspicua* C. B. Adams
*Tritonalia parva* E. A. Smith
*Trivia galapagensis* Melvill
*Trivia pacifica* Gray
*Turbonilla* (?*Strioturbonilla*) sp.
Turrid sp.
*Vermicularia eburnea* Reeve
*Williamia galapagana* Dall

This list contains 106 definitely identified species, with six additional ones, the identity of which is not positive; these latter are compared to previously described species.

In this ancient beach fauna, only two species, "*Mangelia*" *hancocki* Hertlein and Strong, n. sp., and "*Philbertia*" *stonei* Hertlein and Strong, n. sp., are not known in either the Recent West American, or Galapagan fauna. Eighteen of the species have not been recorded living in the waters of the Galapagos Islands. Of course the Recent fauna of the Galapagos Islands is not completely known. It is likely, however, that a considerable part of the common shore and shallow water forms have been collected there,[8] but it is not improbable that all or nearly all of the species cited in the foregoing list may ultimately be found, should intensive collecting be undertaken in the Archipelago.

The ranges of the species in the present fauna, serve to emphasize the predominant Panamic character of the assemblage with, to a lesser degree, some Caribbean affinities. Only a few species show close affinities with the Polynesian or Indo-Pacific faunas, such as the tritons which are wide ranging forms.

Many of the shells retain color markings, or traces of such markings. The fauna is considered to be of a late Pleistocene age.

The following species, included in the preceding list, have not been reported living in the waters of the Galapagos Islands.

| *Species* | *Range* |
|---|---|
| *Astropsammia pedersenii* Verrill | Gulf of California |
| *Antigona isocardia* Verrill | Gulf of California; Tres Marias Islands |
| *Kellia suborbicularis* Montagu | England (type locality); Antilles; British Columbia to Peru (Dall) |
| *Alaba supralirata* Carpenter | Gulf of California (?) to Panama |
| *Alvania veleronis* Hertlein and Strong, n. sp. | Taboga Island, Panama |
| *Aspella erosa* Broderip | Mazatlan to Panama |
| *Cerithiopsis anaitis* Bartsch | Panama |
| *Fossarus atratus* C. B. Adams | Panama |
| *Gadinia peruviana* Sowerby | Gulf of California to Chile (Dall) |
| "*Mangelia*" *hancocki* Hertlein and Strong, n. sp. | Not known Recent |
| *Microcitharia uncinata* Sowerby | Tres Marias Islands; Acapulco, Mexico, to Panama |
| *Mitra funiculata* Reeve | Off Lower California, in Lat. 24°14′ to 24°18′N.; Gulf of California to Panama |
| *Muricopsis dubia* Sowerby | Gulf of California to Panama |
| *Odostomia* (*Miralda*) *incantata* Hertlein and Strong, n. sp. | Bahia Honda, Panama; Taboga Island, Panama |
| *Odostomia orariana* Dall and Bartsch | Panama |
| *Odostomia paupercula* C. B. Adams | Panama |
| "*Philbertia*" *stonei* Hertlein and Strong, n. sp. | Not known Recent |

[8] A. Wimmer. Zur Conchylien-Fauna der Galapagos-Inseln. Sitz. k. k. Akad. Wiss. Wien, **80**, 5: 465–514, (Jahrg. 1879), 1880. — R. E. C. Stearns, Proc. U. S. Nat. Mus., **14**, 854; 307–335, 1891; **16**, 942: 353–450, 1 pl. (Moll.), 1 pl. (map), 1893. — H. A. Pilsbry and E. G. Vanatta. Proc. Washington Acad. Sci., **4**: 549–559, pl. 34, 1902. — T. Soot-Ryen, Pelecypods from Floreana (Sancta Maria) Galapagos Islands. Medd. Zool. Mus. Oslo, No. 27, (Saertrykk Nyt. Mag. Naturvid., **70**): 313–324, 2 pls., 1932.—A. M. Strong and L. G. Hertlein. Marine Mollusks of the Galapagos Islands, unpublished manuscript.

| *Species* | *Range* |
|---|---|
| *Pleurobranchus* sp. | The genus has been recorded from western America, in the Gulf of California, and from the coast of Chile. It also occurs in the West Indies and on the Atlantic coast of Patagonia; also Indo-Pacific |
| *Triphora inconspicua* C. B. Adams | Panama |

Loc. 27250 (C. A. S.). Reddish sandstone beds probably about one and one half meters thick, on beach, on NW. part of the western side of South Seymour Island, Galapagos Islands; L. G. Hertlein, collector; January 2, 1932. Late Pleistocene.

*Eucidaris thouarsii galapagensis* Döderlein
*Arca gradata* Broderip and Sowerby
*Arca reeveana* d'Orbigny
*Arca solida* Sowerby
*Chama* sp.
*Codakia galapagana* Dall
*Alvania veleroana* Hertlein and Strong, n. sp.
*Anachis* cf. *atrametaria* Sowerby
*Cancellaria haemastoma* Sowerby
?*Cantharus* sp.
*Cerithium adustum* Kiener
*Cheilea equestris* Linnaeus
*Crepidula aculeata* Gmelin
*Cypraea nigropunctata* Gray
*Diodora inaequalis* Sowerby
*Engina maura* Sowerby
*Engina reeviana* C. B. Adams
*Fissurella rugosa* Sowerby
*Hipponix antiquatus* Linnaeus
*Hipponix barbatus* Sowerby
*Hipponix grayanus* Menke
"*Mangelia*" sp.
*Marginella* cf. *phrygia* Sowerby
*Mitra ?solitaria* C. B. Adams
*Mitra* (*Strigatella*) *tristis* Swainson
*Morum tuberculosum* Sowerby
*Pyrene fuscata* Sowerby
*Pyrene haemastoma* Sowerby
*Rissoina dina* Bartsch
*Tegula snodgrassi* Pilsbry and Vanatta
*Thais patula* Linnaeus
*Trivia pacifica* Gray
*Trivia* cf. *pulla* Gaskoin

The 26 definitely identified species in the foregoing list have all been recorded living in Galapagan waters. The specimens retain partial color markings in many cases. These fossils were collected from very hard reddish sandy beds containing many fragments of volcanic material. The beds outcrop on the beach and dip at a low angle into the water. This portion of the island is a down faulted block, as shown on Ochsner's map. Recent beach sand occurs on and around the beds thus covering the exact contact of the sediments with the underlying lava.

From a consideration of the facts it would seem best to suggest a late Pleistocene age for the mollusks obtained at this locality.

Loc. 1306 (C. A. S.). On beach about two miles north of Tagus Cove, Albemarle (Isabela) Island; sandstone rocks on beach covered at high tide; J. R. Slevin collector; December 12, 1927. Late Pleistocene or subfossil.

*Bullus punctulatus* A. Adams
*Conus purpurascens* Broderip
*Cypraea nigropunctata* Gray
*Hipponix grayanus* Menke
*Morum tuberculosum* Sowerby
*Nassarius nodicinctus* A. Adams
*Ostrea palmula* Carpenter
*Pyrene castanea* Sowerby
*Pyrene fuscata* Sowerby
*Trivia pacifica* Gray

All of the species in this list have been recorded living in the waters about the Galapagos Islands. Many of the specimens retain much of their original color; others seem to indicate that they have been embedded in sediment.

From the specimens alone, it would seem unwise to venture an opinion as to their antiquity other than that they are probably late Pleistocene in age, or possibly subfossil.

Loc. 27547 (C. A. S.). Below high tide embedded in scoriaceous material at foot of a nine meter cliff on the southeastern shore of Jervis (Rabida) Island, Galapagos Islands; H. W. Clark, collector, Templeton Crocker Expedition; July 6, 1932. Probably Pleistocene.

*Cerithium adustum* Kiener
*Conus purpurascens* Broderip

These two species were found with bones of a mammal (?), embedded in lava fragments. From the evidence of the shells alone, a Pleistocene age is suggested.

## **Alvania veleronis** Hertlein and Strong, new species

Plate 32, figure 18

Shell small, ovate, yellowish white; nuclear whorls two, apparently smooth (more or less eroded in all the specimens); postnuclear whorls 5, slightly rounded, narrowly shouldered at the summit, strongly contracted at the base, sutures deep; spiral sculpture on the second and third whorls of four tuberculate cords, on the last whorl there are 10 equally spaced cords, extending from the suture to the umbilical region, of which the first two are strongly nodulous, the third only slightly so, and the rest at most slightly undulated; axial sculpture of slender, wide spaced, nearly vertical ribs connecting the nodules of the spiral cords; of the axial ribs 16 appear on the third whorl and 18 on the penultimate whorl, where they fade out before reaching the fourth spiral cord; the spaces inclosed by the spiral cords and axial ribs are rectangular pits having their long axes parallel to the spiral sculpture; periphery of the last whorl well rounded; base produced anteriorly, slightly rounded; aperture nearly circular, outer lip thick; inner lip short, thick, continued as a thick callus over the body to a junction with the outer lip. The type measures: length, 2.6 mm.; diameter 1.2 mm.

*Holotype*, No. 700 Calif. Acad. Sci. Paleo. Type Coll., from Loc. 27228 (C. A. S.), dredged in from 3 to 9 fathoms off **Taboga Island, Panama;** Recent; L. G. Hertlein, collector. Seventy additional specimens were dredged at the same locality. This species also occurs at Loc. 27255 (C. A. S.), on a raised beach 5 to 10 meters above sea level, at James Bay, James (San Salvador) Island, Galapagos Islands, Pleistocene, where it was collected by the senior author.

In the key to the west coast species in the genus [9]*Alvania* this would follow *galapagensis* from which it differs decidedly in the details of the sculpture. It is probably nearest to *A. clarionensis* Bartsch[10] from which it differs principally in the fewer and stronger spiral cords.

This species is named for the exploration cruiser *Velero III*, owned by Captain G. Allan Hancock.

### **Odostomia (Miralda) incantata** Hertlein and Strong, new species

Plate 32, figure 19

Shell minute, elongate-conic; white nuclear whorls two and a half, with the axis at right angles to that of the following whorls, in the first of which they are about one-half immersed; postnuclear whorls six, sutures deeply channeled; on the first whorl the sculpture consists of a nodulous spiral cord at the summit and a second smooth one of about equal strength on the middle of the whorl; on the following whorls the nodules of the upper cord become gradually elongated axially and on about the third whorl begin to be divided by a fine, incised, spiral line, this line becomes gradually stronger until on the penultimate whorl there are two spiral lines of nodules separated by a narrow groove, the smooth cord remaining about the same strength and relative position throughout; interspaces between the spiral cords and the lower cord and the suture marked with faint axial riblets corresponding in position to that of the nodules; periphery of the last whorl marked by a smooth spiral cord about equal to that on the spire, below which the base is marked by two similar but smaller spiral cords; aperture oval, the edge of the outer lip broken in the type; columella very short, twisted, the two lower basal cords extending into the aperture. The type measures: length, 2.1 mm.; diameter, 1.0 mm.

*Holotype*, No. 735 Calif. Acad. Sci. Paleo. Type Coll., from Loc. 27228 (C. A. S.), dredged in from 3 to 9 fathoms in **Bahia Honda, Veragua, Panama;** Recent; L. G. Hertlein, collector. Nine additional specimens were dredged at the same locality and three off Taboga Island, Panama.

This species also occurs at Loc. 27255 (C. A. S.), on a raised beach 5 to 10 meters above sea level, at James Bay, James (San Salvador) Island, Galapagos Islands; Pleistocene.

This differs from all the other west coast species in the subgenus *Miralda* in the doubling of the upper nodulous spiral cord on the lower whorls, a character noted on all of the specimens collected.

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[9] Proc. U. S. Nat. Mus., **41**: 334–336, 1912.

[10] Proc. U. S. Nat. Mus., **41**: 356, pl. 32, fig. 4, 1912. "dredged by the United States Bureau of Fisheries steamer *Albatross* off Clarion Island, Mexico, in one of the five hauls — 2991 to 2995, the depths of which ranged from 31 to 460 fathoms."

## **"Mangelia" hancocki** Hertlein and Strong, new species

Plate 32, figure 9

Shell small, slender, with three and a half smooth nuclear whorls and five strongly sculptured normal whorls; axial sculpture of fourteen, low rounded, nearly vertical ribs; spiral sculpture of two, strong, rounded cords on the lower portion of the whorls which rise to elongated tubercles where they cross over the axial ribs; above these there are on the second whorl one, on the third whorl two, and the fourth whorl three, smaller spiral cords which ride over the axial ribs but with less tendency to form tubercles; the periphery of the last whorl marked by a sulcus about as wide as the space between the two major spiral cords; below this is a nodulous spiral cord similar to the two major spiral cords on the upper whorls; base and canal with six spiral cords similar to those on the upper portion of the whorls; outer lip thickened; with a small, rounded, unarmed anal sinus close to the suture, bounded on the inside of the outer lip by a strong denticle, immediately below which there are two smaller denticles; canal short, slightly recurved. The shell is white with irregularly disposed patches of brown, darker in the interspaces between the spiral cords. The type measures: length, 4.0 mm.; diameter, 1.5 mm.

*Holotype*, No. 4693 Calif. Acad. Sci. Paleo. Type Coll., from Loc. 27255 (C. A. S.), raised beach, 5 to 10 meters above sea level, at **James Bay, James (San Salvador) Island, Galapagos Islands;** L. G. Hertlein, collector. Pleistocene.

In size, shape and general appearance this shell is quite similar to "*Mangelia*" (*Steironepion*) *melanosticta* Pilsbry and Lowe[12] but differs in the greater number of spiral cords and in the color pattern. The apparently smooth nuclear whorls are somewhat worn and in fresh specimens may show the spiral keel of *Steironepion*.

This species is named for Captain G. Allan Hancock, owner and captain of the exploration cruiser *Velero III*, through whose courtesy the senior author was privileged to accompany the expedition to the Galapagos Islands in 1931–1932.

## **"Philbertia" stonei** Hertlein and Strong, new species

Plate 32, figure 8

Shell, small, slender, white, the extreme tip broken but the remaining one and a half nuclear whorls smooth; normal whorls four, strongly sculptured with axial ribs and spiral cords which are nodulous at the intersections; axial ribs on the last whorl eight; spiral cords on the spire two; periphery of the body whorl marked by a spiral cord equaling the other spiral cords in strength and partly exposed in the sutures of the upper whorls; base and canal with four similar spiral cords; outer lip greatly thickened, the outer edge scalloped by the ends of the spiral cords, the inner edge without denticles; anal sinus small, rounded, deep, close to the suture, without armature; canal short. The nearly square interspaces between the axial ribs and spiral cords are covered with close, microscopic, axial striations which may be due to the weathered condition. Length, 4.0 mm.; diameter, 1.8 mm.

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[12] Proc. Acad. Nat. Sci. Philadelphia, **84**: 56, pl. 3, fig. 9, 1932. "San Juan del Sur, Nicaragua."

*Holotype*, No. 4694, Calif. Acad. Sci. Paleo. Type Coll., from Loc. 27255 (C. A. S.), raised beach, 5 to 10 meters above sea level, **James Bay, James (San Salvador) Island, Galapagos Islands;** L. G. Hertlein, collector. Pleistocene.

This species belongs in the group placed by Dall in the genus *Philbertia* but that name does not seem available, and much further study will be required before the various species can be arranged in proper genera and subgenera. In many ways the species resembles "*Philbertia*" *trichodes* Dall (*Pleurotoma hirsutum* de Folin)[13] from the same fauna. It differs in the lack of the peculiar projection of the nodules in that species.

This species is named for Mr. George Stone, photographer on the *Velero III*, who called the senior author's attention to the raised beach, from which the type specimen was later collected.

## **Transennella** Dall

*Transennella* DALL, Proc. U. S. Nat. Mus., **6**; 340, 341, 1883. Type (by monotypy): *Cytherea* (*Transennella?*) *conradiana* DALL, 1883: 340. "Rare at Cedar Keys, in mud between tides."—Figured by DALL, U. S. Nat. Mus., Bull. 37, 2nd ed., pl. 90, fig. 6, 1903; also Proc. U. S. Nat. Mus., **26**, pl. 13, fig. 6, 1903. [Not fig. 5 as cited on explanation to plate 13.]—VAN WINKLE PALMER, Palaeontogr. Amer., **1**, 5: 91, text fig. 10 and pl. 16, figs. 4, 8, 10, 1929.—See also Grant and Gale, Mem. San Diego Soc. Nat. Hist., **1**: 338, 1931.

*Transennella* is reported to range from Miocene to Recent. In the California Tertiary, *T. joaquinensis* Anderson and Martin,[14] has been recorded from the lower or middle Miocene of Kern County; and Arnold[15] has recorded *Transennella californica* Arnold, from the Pliocene of the south end of Kettleman Hills, San Joaquin Valley, California. *T. tantilla* Gould has been recorded from Pleistocene and Recent. *Transennella herviderana* Spieker[16] has been described from the Miocene of Peru. Other species have been recorded from Miocene to Recent in eastern North America.

During the work of identification of a small species referred to *Transennella*, collected both as a living shell and as a fossil in the Galapagos Islands, it was necessary to review all the west coast species belonging to the genus. For many years the only species placed therein was "*Venus tantillus* Gould."[17] This is a well known

[13] See Proc. U. S. Nat. Mus., **56**: 62, pl. 13, fig. 1, 1919. "Panama Bay."

[14] Proc. Calif. Acad. Sci., (4), **4**: 60, pl. 3, figs. 6a, 6b, 6c, 1914. "On west bank of a small canyon 1¼ miles northeast of Barker's ranch house, Kern County, California." Miocene.

[15] U. S. Geol. Surv., Bull. 396: 72, pl. 26, figs. 7, 7a, 1909. "South end of Kettleman Hills, Sec. 10, T. 25 S., R. 19E." Pliocene.

[16] *Transennella herviderana* Spieker, Johns Hopkins Univ. Studies in Geol., No. 3: 143, pl. 9, figs. 1, 2, 1922. "Lower Zorritos. Hervideras." — Olsson, Bull. Amer. Paleo., **19**, (Bull. No. 68): 121, pl. 10, fig. 2, 1932. "Lower Zorritos of Hervideras (Spieker), Zorritos of Que. Cardalitos."

[17] Boston Jour. Nat. Hist., **6**: 406, pl. 15, fig. 10, 1853. "Inhabits Santa Barbara. *Col. Jewett.*"

shell ranging from Sitka, Alaska, to San Martin Island, Lower California. It was described as a white shell with "the posterior third stained deep slaty blue outside and in." While this color pattern is not uncommon, it is lacking in many specimens and nearly all show on the outside more or less distinct, tent-shaped brown lines. There are three cardinal teeth in each valve and a short, strong, left lateral fitting into a socket with raised edges in the right valve. On the inner basal margin of the valves there are a few rather indistinct, oblique grooves. On account of these grooves and the hinge formula Dall placed the species in the genus *Transennella.*

Carpenter described[18] a "*Callista* (? *pannosa*, var.) *puella*" from Cape San Lucas. Of this, in another place he said,[19] "The name *puella* given to the Cape San Lucas specimens was intended as varietal; although Mr. Cuming regards the Peruvian and Peninsular forms as distinct. It is not known along the Central American coast." Dall[20] considered *puella* to be a distinct species and placed both in the genus *Macrocallista*, quoting the range for *M. pannosa* Sowerby[21] as from the Gulf of California to Chile.

Pilsbry and Lowe[22] stated regarding *puella*, that it has the "oblique grooves in the ventral edges of the valves, and should, we believe, be transferred to *Transenella.*" So far as we have discovered, *Transennella puella* Carpenter has not been illustrated heretofore. *Transennella sorocula* Pilsbry and Lowe,[23] from Nicaragua, is decidedly a larger species with more distinct, concentric sculpture. A specimen of *T. sorocula* from Loc. 27584 (C. A. S.), Lat. 23°03′ to 23°06′ N., Long. 109°31′ to 109°36′ W., in 20–200 fathoms, measures 35 mm. in length and 31.8 mm. in height.

A comparison of specimens of *tantilla* from California with the large series of *puella* from Cape San Lucas in the collections of the California Academy of Sciences, and with specimens of *pannosa* from Chile in the collection of Mr. H. N. Lowe, shows them to have almost identical hinge characters and similar grooves on the ventral margin of the valves. In all three the color is variable with the lighter colors predominating in the colder water and the darker forms in the warmer water. The tent shaped brown lines are nearly always present. The principal differences are in size and in the angle at which the dorsal margins meet at the beaks, resulting in small differences in the outline of the shell. *T. tantilla* Gould is a fairly

[18] Ann. and Mag. Nat. Hist., (3), **12**: 313, 1864.

[19] Suppl. Rept. Brit. Assoc. Adv. Sci. for 1863 (issued 1864), p. 572.

[20] Proc. U. S. Nat. Mus., **26**: 387, 1902.

[21] *Cytherea pannosa* Sowerby, Proc. Zool. Soc. London, 1835: 47. "*Hab.* ad oras Chilenses (Coquimbo)." "Found in sandy mud at low water. — G. B. S." — Sowerby, Thes. Conch., **2**, *Cytheraea*, 635, pl. 133, figs. 140, 141, 142, 1851; pl. 163, figs. 202, 203, 1853. "Coquimbo; in sandy mud at low water. *Cuming.*" — See also Reeve, Conch. Icon., **14**, *Dione*, October, 1863, sp. 62, pl. 12, figs. 62a, 62b, 62c. "Hab. Chili, Peru, Mazatlan." — Dall, Proc. U. S. Nat. Mus., **37**: p. 266, 1909, (as *Macrocallista pannosa*). "Gulf of California south to Valparaiso, Chile."

[22] Proc. Acad. Nat. Sci. Philadelphia, **84**: 102, 1932.

[23] Proc. Acad. Nat. Sci. Philadelphia, **84**: 102, 1932.

thick shell reaching a maximum length of about 10 mm. and the angle at the beaks is approximately 90°. *T. puella* Carpenter reaches a length of about 16 mm. and is a thinner shell with the angle at the beaks wider, about 120°; *T. pannosa* Sowerby is a still larger and heavier shell, reaching a length of about 30 mm. The angle at the beaks is about 90°. The record of *T. pannosa* Sowerby from the Gulf of California is probably based on the consideration that *T. puella* Carpenter is a variety. The record "*Macrocallista pannosa*" from Guadalupe Island, cited by Strong and Hanna,[24] can be referred to *T. puella* Carpenter, a species commonly found in the Gulf of California. We can locate no specimen or definite record of *T. pannosa* north of Peru. The specimens recorded by Pilsbry and Lowe, as *Macrocallista pannosa* dredged in 20 fathoms at San Juan del Sur, Nicaragua, could better be referred to *T. puella* Carpenter. We now add a fourth species to this closely related group.

### **Transennella galapagana** Hertlein and Strong, new species

Plate 32, figures 1, 2, 3, 6, 7

This shell has the same hinge as *T. tantilla* Gould, *T. puella* Carpenter and *T. pannosa* Sowerby, and similar oblique lines on the ventral margins of the valves. The color pattern is also quite similar and equally variable, ranging from white to purple brown, with tent shaped brown lines on the somewhat polished, smooth surface. The surface in some specimens is ornamented by fine microscopic concentric striae. It is much the smallest of the group but comparatively thick, and of slightly different outline, with the angle at the beaks about 110°. The small size of the tent shaped markings near the beaks show that this is a fully adult shell. Length of type, 5.9 mm.; height, 4.0 mm.; thickness of the two valves, 3.0 mm.

*Holotype*, No. 6904, and paratypes 6905-6909 Calif. Acad. Sci. Paleo. Type Coll., from Loc. 27232 (C. A. S.), on the beach in shallow water, **Conway Bay, Indefatigable (Santa Cruz) Island, Galapagos Islands;** Recent; L. G. Hertlein, collector. About 150 additional living specimens and several hundred empty valves were secured at the same place. This species also occurs fossil at Loc. 27255 (C. A. S.), on raised beach, 5 to 10 meters above sea level, at James Bay, James (San Salvador) Island, Galapagos Islands; Pleistocene.

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[24] Proc. Calif. Acad. Sci., (4), **19**, 1: 1–6, 1930.

Plate 32

Fig. 1. *Transennella galapagana* Hertlein and Strong, new species; holotype No. 6904, C. A. S. Paleo. type coll.; altitude 4.0 mm., length 5.9 mm.; from Loc. 27232 (C. A. S.), on the beach in shallow water, Conway Bay, Indefatigable (Santa Cruz) Island, Galapagos Islands; Recent. This species also occurs at Loc. 27255 (C.A.S.), raised beach, 5 to 10 meters above sea level at James Bay, James (San Salvador) Island, Galapagos Islands; Pleistocene. P. 378.

Fig. 2. *Transennella galapagana* Hertlein and Strong, new species; paratype left valve, No. 6905, C. A. S. Paleo. type coll.; altitude 4.8 mm., length 5.9 mm.; from the same locality as the holotype shown in figure 1. P. 378.

Fig. 3. *Transennella galapagana* Hertlein and Strong, new species; paratype right valve, No. 6906, C. A. S. Paleo. type coll.; altitude 3.8 mm., length 5.3 mm.; from the same locality as the holotype shown in figure 1. P. 378.

Fig. 4. *Tritonalia parva* E. A. Smith; hypotype No. 6957, C. A. S. Paleo. type coll.; length 13.9 mm., diameter approximately 9.1 mm.; from Loc. 27255 (C. A. S.), raised beach 5 to 10 meters above sea level at James Bay, James (San Salvador) Island, Galapagos Islands. Pleistocene. P. 370.

Fig. 5. *Colubraria lucasensis* Strong and Hertlein; hypotype No. 4695, C. A. S. Paleo. type coll.; length 40 mm., diameter 13.9 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 370.

Fig. 6. *Transennella galapagana* Hertlein and Strong, new species; a drawing showing the dorsal view of the holotype shown in figure 1. P. 378.

Fig. 7. *Transennella galapagana* Hertlein and Strong, new species; a drawing showing the characters of the interior of the specimen shown in figure 2. P. 378.

Fig. 8. "*Philbertia*" *stonei* Hertlein and Strong, new species; holotype No. 4694, C. A. S. Paleo. type coll.; length 4.0 mm., diameter 1.8 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 375.

Fig. 9. "*Mangelia*" *hancocki* Hertlein and Strong, new species; holotype No. 4693, C. A. S. Paleo. type coll.; length 4.0 mm., diameter 1.5 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 375.

Fig. 10. *Aspella pyramidalis* Broderip; hypotype No. 6958, C. A. S. Paleo. type coll.; length (incomplete), 10.5 mm., diameter 5.2 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 369.

Fig. 11. *Transennella sorocula* Pilsbry and Lowe; hypotype left valve No. 6960, C. A. S. Paleo. type coll.; length 35 mm., height 31.8 mm.; from Loc. 27584 (C. A. S.), Lat. 23°03′ to 23°06′ N., Long. 109°31′ to 109°36′ W., dredged from 20 to 220 fathoms. About 10 miles due east of San Jose del Cabo, Lower California: Recent; Templeton Crocker Expedition. View of the interior of the left valve. P. 377.

Fig. 12. *Transennella sorocula* Pilsbry and Lowe; hypotype right valve No. 6960a, C. A. S. Paleo. type coll.; exterior view of the right valve of the specimen shown in figure 11. P. 377.

Fig. 13. *Aspella pyramidalis* Broderip; hypotype No. 6959, C. A. S. Paleo. type coll.; length approximately 7.6 mm., diameter approximately 3.6 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 369.

(*Concluded on next page*)

PLATE 32—(*Concluded*)

Fig. 14. *Transennella puella* Carpenter; hypotype right valve No. 6961, C. A. S. Paleo. type coll.; length 14.8 mm., height 11.2 mm.; from Loc. 24062 (C. A. S.), Cape San Lucas, Lower California; Recent; E. C. Johnson coll. Interior view of right valve. P. 377.

Fig. 15. *Transennella puella* Carpenter; hypotype left valve No. 6961a, C. A. S. Paleo. type coll.; view of the interior of the left valve of the specimen shown in figure 14. P. 377.

Fig. 16. *Transennella puella* Carpenter; hypotype right valve No. 6962, C. A. S. Paleo. type coll.; length 14.2 mm., height 11.6 mm.; from Loc. 27587 (C. A. S.), dredged off Cape San Lucas, Lower California in 20 to 220 fathoms; Recent; Templeton Crocker Expedition. View of the exterior of the right valve showing the tent shaped markings. P. 377.

Fig. 17. *Caducifer thaleia* Pilsbry and Lowe; hypotype No. 4696, C. A. S. Paleo. type coll.; length 31.6 mm., diameter 9.6 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 370.

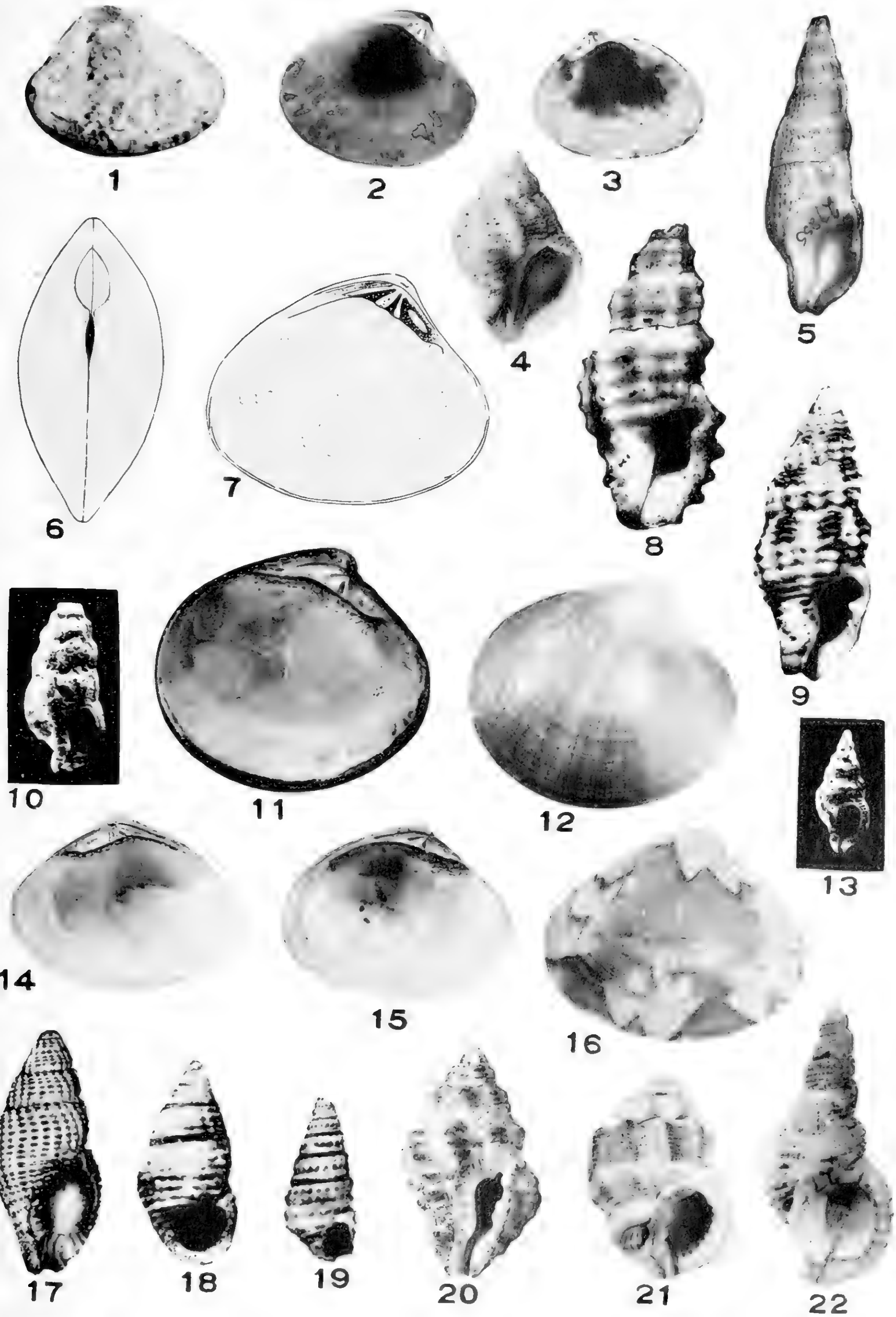
Fig. 18. *Alvania veleronis* Hertlein and Strong, new species; holotype No. 700, C. A. S. Paleo. type coll.; length 2.6 mm., diameter 1.2 mm.; from Loc. 27228 (C. A. S.), dredged in from 3 to 9 fathoms off Taboga Island, Panama; Recent. This species also occurs at Loc. 27255 (C. A. S.), on a raised beach, 5 to 10 meters above sea level at James Bay, James (San Salvador) Island, Galapagos Islands; Pleistocene. P. 373.

Fig. 19. *Odostomia* (*Miralda*) *incantata* Hertlein and Strong, new species; holotype No. 735, C. A. S. Paleo. type coll.; length 2.1 mm., diameter 1.0 mm.; from Loc. 27229 (C. A. S.), dredged in from 3 to 9 fathoms at Bahia Honda, Veragua, Panama; Recent. This species also occurs at Loc. 27255 (C. A. S.), raised beach at James Bay, James (San Salvador) Island, Galapagos Islands; Pleistocene. P. 374.

Fig. 20. *Engina reeviana* C. B. Adams; hypotype No. 6963, C. A. S. Paleo. type coll.; length 16.8 mm., diameter approximately 11.1 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 370.

Fig. 21. *Cancellaria haemastoma* Sowerby; hypotype No. 6964, C. A. S. Paleo. type coll.; length 19.8 mm., diameter 14.4 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 370.

Fig. 22. *Craspedotriton scalariformis* Broderip; hypotype No. 6965, C. A. S. Paleo. type coll.; length (incomplete), 37.3 mm., diameter approximately 18 mm.; from the same locality as the specimen shown in figure 4; Pleistocene. P. 370.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No. 25

# NOTES ON SOME FORMS OF OREOHELIX STRIGOSA (Gould)*

BY

G. DALLAS HANNA
*Curator, Department of Paleontology*

AND

ALLYN G. SMITH
*Research Associate*

Fifty years ago Henry Hemphill collected large numbers of *Oreohelix* from which he described many species, varieties, and forms. He was the pioneer in the areas where this genus dominates the land-shell fauna. In addition to finding many novelties he devised a scheme of classification that called for a distinct name for the several variants in the same species, sometimes in the same colony. Even aberrant color forms such as albinos were given names by him. Representatives of most of his material with notes and descriptions were sent to W. G. Binney from time to time, and later "sets" were variously distributed.[1] It is clear from an examination of some of the lots thus sent that he did not use very great care in making the selections; some of this semi-commercial material definitely does not agree with the type lots that he held in his own collection. Binney

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[1] See Henderson & Daniels, Proc. Acad. Nat. Sci. Philadelphia, 1916: 315-316, for an account of some of these sets.

illustrated a few of the named forms, but in the majority of cases the figures are too poor to aid much in identification.

Hemphill's descriptions were rather generalized. As a consequence, his names have been obstacles to every worker in *Oreohelix* since his time. Various interpretations have been made and some clarification has taken place but uncertainty still pertains to many.

In 1931 one of us (A. G. S.) made a collecting trip through eastern Oregon, Washington, and western Idaho and some material of the *O. strigosa* group was collected. Upon attempting to identify these shells recourse was had to comparisons with specimens in the original Hemphill collection, now in the California Academy of Sciences and excellently arranged for consultation. We were at once impressed with the difficulties under which other workers must labor who do not have the original collection available; and we decided that it would be desirable to present adequate illustrations of Hemphill's type specimens of all of the named forms from the area concerned.

Very little has been learned by us about the details of the methods used by the great collector in assembling his material or disposing of it subsequently, as none of his correspondence accompanied the collection to the Academy. It is evident, however, from his original catalogs and his sorting and numbering, that he kept his largest suites and his best specimens for his own collection. He sorted his lots in various ways and gave separate numbers to each segregation. Those to which he gave distinct names are so labelled, and often a particular lot will have "Types" written on the label in his handwriting.

The wealth of material in the collection is such that we feel justified in presenting rather complete information on all of the named forms from the northwestern part of the range of the genus. Except for the Hemphillian forms, we have not attempted to present a complete review of the species. Henderson has given an adequate synonymy and no useful object would be gained by repeating it[2]. More recently Pilsbry[3] has contributed an excellent review of the group, based largely on anatomical characters, as well as the shells. This represents the latest word toward an authoritative classification and includes a catalog of all of the species of the genus.

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[2] Henderson, Junius. Univ. Colorado Studies, **13**, 2, 1924 and **17**, 2, 1929.

[3] Pilsbry, H. A. Proc. Acad. Nat. Sci. Philadelphia, **85**: 383-410, pls. 14, 15. March 3, 1934.

## 1. **Oreohelix strigosa** (Gould)

Plates 33, 34, 35

*Helix strigosa* Gould, Proc. Boston Soc. Nat. Hist. **2**:166, 1846.—Gould, U. S. Explor. Exp. Moll. 1852, p. 36; Atlas 1856, pl. 3, figs, 41, 41a, 41b.—Binney, Terr. Moll. **2**:210, 1851; **3**:1857, pl. 26a, 3 figures.

*Patula strigosa* (Gould), Binney, W. G., Terr. Moll., **5**, (Bull. Mus. Comp. Zool. Harvard College, **4**):157, 1878, fig. 64 (lower), fig. 65 (upper) both as *P. cooperi:* pl. 4, fig. H [dentition]; pl. 11, fig. A [genitalia]. [Identity of dentition and genitalia doubtful.]—Binney, 2nd Suppl. Terr. Moll., **5**, (Bull. Mus. Comp. Zool. Harvard College, **13**, **2**:26–34, 1886. [Contains discussion of the group and (pl. 2, fig. 10) a figure of an Oregon specimen.]

*Oreohelix strigosa* (Gould), Henderson, Univ. Colorado Studies, **17**, 2:88–89, 1929. —Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, **85**:383–384, pl. 14, figs. 2–11, 28–31; pl. 15, fig. 13, 1934.—Smith, Nautilus, **50**, 3:73–77, Jan. 1937.

Proper evaluation of the Hemphillian shells and the collections made in 1931 led to an investigation of the circumstances surrounding the discovery of the species which has already been published. (See last reference above.) Although partly based on circumstantial evidence, the conclusion drawn was that the type locality of *Oreohelix strigosa* is in the valley of the Columbia River not far from the mouth of the Entiat River, north of Wenatchee, Chelan County, Washington.

A series of shells from this locality was sent to William B. Marshall of the U. S. National Museum, who compared them with Gould's type specimen, (U. S. Nat. Mus. No. 5441). Mr. Marshall found the set to be very similar and, from the lot, he returned a single shell which he stated was extremely close, especially in coloration, but which showed a somewhat rounder and less oblique aperture. This shell, (C. A. S. No. 5843) is shown on plate 33, figures 1–3, and came from Entiat, Washington; diam. 21.5 mm., alt. 11.0 mm. Figures 4–6 of the same plate represent a larger specimen from rock slides four miles north of Entiat; diam. 23.7 mm., alt. 11.4 mm. Among 15 additional specimens from Entiat the largest and smallest in diameter are 25.8 mm. and 21.8 mm. respectively, while the highest and lowest are 13.4 mm. and 11.1 mm. respectively. The average is, diam. 23.8 mm., alt. 12.4 mm. Among 10 specimens from four miles north of Entiat the largest is 27.2 mm. in diameter and the smallest 22.4 mm.; greatest altitude, 14.0 mm. and least 10.9 mm. The average is, diam. 24.6 mm.; alt. 12.4 mm.

The living specimens in the lot from Entiat were kept alive for some time, and many of them gave birth to a number of young, which were dark horn-color, consisted of about two and one-half whorls, and measured from 4.0 to 4.8 mm. in diameter. Sculpture is absent on the first whorl, then spiral lines appear, which gradually merge into a few spiral ridges on the last half turn. All of the young are low-spired, being almost planulate, and all are strongly keeled.

Color variation among the adult shells is considerable, as might be expected. The predominant color-form has a ground of grayish white on which are superimposed two well-defined, dark chestnut bands, the wider and more strongly colored one just below the periphery, the other about half way between the periphery and the suture of the last whorl. The upper band usually is discontinuous and indistinct on the early whorls. Bands on the base vary from two or three well-marked hair lines of chestnut-brown to about the same number of wider but less distinct bands. A few shells (three or four in the lot from Entiat) have no bands above and are darker than the rest, being generally suffused with chestnut. The banding below is either distinct or else clouded with chestnut color on this form, which approximates that existing on the type specimen in the National Museum.

From the above it would seem logical to assume that the original specimen of *O. strigosa* was collected in the valley of the Columbia River, not far from where the Entiat River enters it, and this is accordingly designated the type locality.

The set taken at Entiat consists of 39 full grown, adult shells or nearly so, and 12 immature specimens. Four miles north of Entiat a set of 13 adults and 5 young shells were taken. These average somewhat larger and heavier than the lot from Entiat, and contained more of the darker colored shells without pronounced banding.

Hemphill referred nine varieties from Oregon, Washington and Idaho to *strigosa*. In chronological order these are *bicolor*, *subcarinata*, *lactea*, *jugalis*, *intersum*, *parma*, *fragilis*, *picta* and *castanea*. Henderson described *castanea* as a distinct species which, however, Pilsbry later referred to *strigosa* as a subspecies. The latter also considered *fragilis* to be a subspecies. Furthermore, he described the subspecies *goniogyra* and *delicata* from near Riggins, Idaho and Milton, Oregon, respectively, and the species *junii* (in a different group of *Oreohelix*) from the Grand Coulée, Washington. Specimens representing the last three names have not been critically examined in connection with the preparation of the present review, but a study of the original type lots of the Hemphill material has convinced us that *bicolor*, *subcarinata*, *lactea*, *jugalis*, *parma* and *picta* are strictly synonymous with *strigosa* and are not recognizable, even as varieties. The remaining three of the Hemphill segregation, *intersum*, *fragilis* and *castanea* (=*variabilis*) are believed to be distinct species. This last conclusion, however, is subject to the uncertainty always involved when nothing is known of the field relationships, anatomy and life history of the species. Representatives of each of the nine names listed have been selected for illustration herewith in order to assist in the stabilizing of the nomenclature of the group and, it may be added, the Academy series are maintained intact as Hemphill segregated them. Notes on these lots follow.

## **Oreohelix strigosa subcarinata** (Hemphill)

Plate 34, figures 4, 5, 6

*Patula strigosa* var. *subcarinata* Hemphill, Nautilus, **3**, 133, April, 1890. "Rathdrum, Idaho."—Binney, 3rd Suppl. Terr. Moll. **5**, (Bull. Mus. Comp. Zool. Harvard College; **19**, 4) :215, May, 1890, text fig.—Binney, 4th Suppl. (B. M. C. Z. **22**, 4) Jan. 1892, p. 171. [Reprint of notes in above papers.]—Pilsbry, Man. Conch. ser. 2, **8**:118, Feb. 25, 1893, pl. 41, fig. 96.

*Oreohelix strigosa* form *subcarinata* Hemphill, Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, **85**:386, 1934, pl. 14, figs. 28–30; "Rathdrum, Idaho, paratypes."

The variety *subcarinata* is represented in the Hemphill collection at the California Academy of Sciences by six lots of shells, labelled by the collector; five lots are from "Rathdrum, Idaho," and one is merely marked "Idaho." No type or "types" were designated. In the 3rd Supplement, Binney gave the locality as "Old Mission, Coeur d'Alene, Idaho," but there is nothing in the collection or in Hemphill's notes to indicate that this is correct.

In 1893 Pilsbry selected the specimen figured by Binney (3rd Suppl. 1890, p. 215) as the "type" and in 1934 he designated the three specimens he then figured as "paratypes."

Nineteen shells from Rathdrum, Idaho (Hemphill's numbers, 7627, 7629, 7631–7633) vary from 22.0 mm. to 29.7 mm. in diameter and from 14.8 mm. to 20.5 mm. in altitude; the average is, diam. 25.2 mm.; alt. 17.3 mm.

## **Oreohelix strigosa jugalis** (Hemphill)

Plate 35, figures 1, 2, 3

*Patula strigosa* var. *jugalis* Hemphill in Binney, 3rd Suppl. Terr. Moll. **5**, (Bull. Mus. Comp. Zool. **19**, 4) May, 1890, p. 215, text fig. "Banks of Salmon River, Idaho."—Hemphill, Nautilus, **3**:134, 1890.—Binney, 4th Suppl. Terr. Moll. **5**, (Bull. Mus. Comp. Zool. **22**, 4) Jan., 1892, p. 169.—Pilsbry, Man. Conch. ser. 2, **8**:117, 1893, figs. 93–95.

*Oreohelix jugalis* Hemphill, Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, **85**:398.

The variety *jugalis* is represented in the collection by three lots labelled by Hemphill from "Salmon River Mountain, Idaho." None of the specimens are as deformed as the one figured by Binney in the "3rd Supplement," but all show a tendency toward a depressed body whorl. The same feature, however, is displayed to some extent by Gould's original figure of *strigosa*. It is believed that Hemphill used the name *jugalis* as a receptacle for those individuals showing the most pronounced tendency toward depression of the aperture.

In 1934 Pilsbry recognized this form as a distinct species because of the "very wide umbilicus, the closely approaching upper and columellar margin of the peristome, which is occasionally continuous, and the weak or obsolete spiral sculpture." He chose specimen No. 62372 (A. N. S. P.) as lectotype and Lucile, Idaho as the type locality.

The shells in the three lots mentioned (Nos. 7700–7702 H. H. coll.) range in diam. from 17.2 mm. to 24.8 mm. and in alt. from 9.0 mm. to 13.5 mm.; the average is, diam. 20.9 mm.; alt. 11.4 mm. These shells are so similar to *strigosa* and intergradation is so complete that we have been obliged to refer them to that name. Since Hemphill's description may be presumed to have been based upon this material with reasonable assurance, at least in part, we feel justified in calling the specimen selected for illustration a "syntype." This action is in accordance with the definition of the term as adopted by Frizzell[4]. If at a later date, additional study should show that our reference of the series here considered, to *strigosa* as a synonym is wrong and that, in fact, it is distinct from that form as well as from the one Dr. Pilsbry called *jugalis* and for which he properly designated a lectotype, then this series would presumably require a new name.

## **Oreohelix strigosa bicolor** (Hemphill)

Plate 35, figures 7, 8, 9

*Patula strigosa* var. *bicolor* HEMPHILL, Nautilus, **3**:133, 1890. "Rathdrum, Idaho." —BINNEY, 4th Suppl. Terr. Moll. **5**, (Bull. Mus. Comp. Zool. Harvard College, **22**, 4), Jan. 1892, p. 172, pl. 4, fig. 7.—PILSBRY, Man. Conch. ser. 2, **8**:118, 1893, pl. 41, figs. 3, 4.

*Oreohelix strigosa subcarinata* plus *bicolor* HEMPHILL, PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, **85**:386, 1934.

Hemphill stated that this was merely a color form of his var. *subcarinata*, the prevailing pattern being blotches of a dark horn shade interspersed with dirty white. No bands are present. He left 15 specimens definitely labelled *bicolor* and most of these answer the description fairly well. Many of the shells show intergradation with what he selected as *subcarinata*. They bear numbers 7634, 7635 and 7636, (H. H.). The variation in diam. is 18.6 mm. to 27.6 mm. and in alt. 12.1 mm. to 19.7 mm., the average being diam. 24.0 mm.; alt. 16.0 mm.

[4] Frizzell, D. L. Terminology of types. American Midland Naturalist, **14**, 6: 637-668, 1933.

## **Oreohelix strigosa lactea** (Hemphill)

Plate 35, figures 4, 5, 6

*Patula strigosa* var. *lactea* Hemphill, Nautilus, **3**:134, 1890. "Rathdrum, Idaho."—Binney, 4th Suppl. Terr. Moll. **5** (Bull. Mus. Comp. Zool. Harvard College, **22**, 4), Jan. 1892, p. 172, pl. 4, fig. 8.—Pilsbry, Man. Conch. ser. 2, **8**:118, 1893, pl. 41, fig. 99.

*Oreohelix strigosa subcarinata* form *lactea* Hemphill, Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, **85**:386, 1934.

This name was applied to a series of albinistic shells. It is not quite clear from Hemphill's note whether he found a colony of these milk-white shells without admixture of other normal ones, but that might be inferred. He left two lots (No. 7637, 5 sp., No. 7638, 4 sp.) in his collection labelled *lactea*. The first, marked "Types," is from "Rathdrum, Idaho;" these vary in diameter from 23.5 mm. to 28.5 mm. and 17.0 mm. to 21.2 mm. in altitude, the average being, diam., 26.4 mm., alt. 18.6 mm.

Under No. 7638, he recorded a set of four white shells from Salt Lake City, Utah, as *Helix strigosa* var. *lactea;* we have not attempted to place these exactly because they were not mentioned in the original description of the variety.

## **Oreohelix strigosa parma** (Hemphill)

Plate 33, figures 7, 8, 9; plate 34, figures 1, 2, 3

*Patula strigosa* var. *parma* Hemphill, Nautilus, **4**:17, 1890. "Near Spokane Falls, Washington."—Binney, 4th Suppl. Terr. Moll. **5**, (Bull. Mus. Comp. Zool., **22**, 4), Jan. 1892, p. 173.—Pilsbry, Man. Conch. ser. 2, **8**:117, 1893, pl. 42, figs. 7, 8, **9**.

*Oreohelix strigosa* form *parma* (Hemphill), Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, **85**:384, 386, 409, 1934, pl. 14, fig. **1** [synonymous with *strigosa*].

Hemphill left two lots (7625, 7626 H. H.) labelled *parma* and these are believed to be close to the original *strigosa*. There is considerable variation in the series, with no two shells being exactly alike. Actually very few conform to the original description, but those chosen as syntypes and figured herewith are closest. Variation in diameter is from 22.1 mm. to 27.8 mm. and in altitude from 13.0 mm. to 14.8 mm., the average of 10 being, diam. 24.7 mm.; alt. 13.8 mm.

How it was possible for Hemphill to justify his separation of these shells from what he called *subcarinata* is difficult to determine; the two series seem to us to show perfect intergradation. Pilsbry stated in 1934 that the specimen he then illustrated was a paratype of the form *parma* and also that it was strictly synonymous with *strigosa*.

### **Oreohelix strigosa picta** (Hemphill)

Plate 34, figures 7, 8, 9

*Patula strigosa* var. *picta* HEMPHILL, Nautilus, **4**:16, 1890. "Rathdrum, Idaho." —BINNEY, 4th Suppl. Terr. Moll. **5**, (Bull. Mus. Comp. Zool., **22**, 4), Jan. 1892, p. 175.—PILSBRY, Man. Conch. ser. 2, **8**:118, 1893, pl. 41, figs. 1, 2; [equals *subcarinata*].—PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, **85**:386, 1934, pl. 14, fig. 28, "type."

The Hemphill Collection contains one lot (5 specimens) labelled *Helix strigosa* var. *subcarinata picta;* it is obvious from his description and from the aspect of these shells themselves that he had in hand one of the color phases of his "*subcarinata*." We have, therefore, selected from the series bearing that name the specimen for illustration that most closely conforms to the description. No other agrees with it in all details. Pilsbry stated in 1934 that the form was not distinct, and segregated specimen No. 62284 of the Philadelphia Academy as "type" [=lectotype]. This was evidently a part of some lot distributed by Hemphill. The five shells vary from 22.4 mm. to 28.8 mm. in diam., and 17.3 mm. to 19.4 mm. in alt.; the average being, diam. 24.6 mm. and alt. 18.3 mm.

### 2. **Oreohelix intersum** (Hemphill)

Plate 36, figures 1, 2, 3

*Patula strigosa* var. *intersum* HEMPHILL, Nautilus, **3**:135, 1890. "Banks of Little Salmon River, Idaho."—BINNEY, 4th Suppl. Terr. Moll. **5**, (Bull. Mus. Comp. Zool. Harvard College, **22**, 4), Jan. 1892, p. 170.—PILSBRY, Man. Conch. ser. 2, **8**:117, 1893, pl. 41, figs 91, 92.

*Oreohelix jugalis intersum* HEMPHILL, PILSBRY, Proc. Acad. Nat. Sci. Philadelphia, **85**:398, 406, 1934.

The two lots of measured specimens (Nos. 7616, 7618 H. H.) were recorded by Hemphill with the following note: "Shell faintly subcarinate; fine riblike striae." The lectotype has been selected from them because he mentioned the striae in his description, and this seems to be constant through the series. The character is so pronounced that for the present, we feel disposed to recognize the shells as specifically distinct from *strigosa* and from other named forms. Pilsbry, in 1934, considered the form to be a subspecies of *jugalis* which, however, cannot be separated from *strigosa* with the material we have available.

Under the name *intersum* Hemphill recorded five additional lots of specimens all separated under the heading: "Shell subcarinate, surface smooth." The lots are numbers 7620–7624 inclusive. No. 7620 is from Salmon River Mountains, Idaho, five specimens. These are smooth chestnut-colored shells with a white, peripheral band. No. 7621 (5 specimens) is from the same place and were separated because they were "depressed." We believe these two lots of shells belong to a distinct species that has not yet been described, but we refrain from assigning a name at this time because of the indefiniteness of the locality. Numbers 7622 (7 sp.), 7623 (7 sp.), and 7624 (7 sp.), are from Box Elder County, Utah, and obviously belong to a species different from *strigosa*, *intersum*, or the one just discussed.

The ten specimens in lots 7617 and 7618 vary in diam. from 15.2 mm. to 19.9 mm. and in alt. from 8.9 mm. to 12.0 mm., the average being, diam. 17.5 mm. and alt. 10.6 mm.

### 3. **"Oreohelix" fragilis** Hemphill

Plate 36, figures 4, 5, 6

*Patula strigosa* var. *fragilis* Hemphill, Nautilus, **4**:17, 1890. "Near Franklin, Idaho, among red sandstone."—Binney, 4th Suppl. Terr. Moll. **5**, (Bull. Mus. Comp. Zool. **22**, 4), Jan. 1892, p. 174.—Pilsbry, Man. Conch. ser. 2, **8**:117, 1893, pl. 41, figs. 5, 6.

*Oreohelix strigosa fragilis* Hemphill, Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, **85**:408, 1934.

The collection contains five lots, 21 specimens, that Hemphill labelled *fragilis* from near Franklin, Idaho. Most of these shells are thin and somewhat translucent. They may reasonably be held as a distinct species as we have not been able to find intergradation with other forms. A specimen has been selected as lectotype and illustration that conforms as closely to the original description as possible. The 21 shells vary in diam. from 15.2 mm. to 19.9 mm., and in alt. from 9.5 mm. to 14.5 mm., the average being, diam. 18.6 mm.; alt. 14.0 mm. No. 7664 is sinistral.

All of these shells are brown in color and quite thin for *Oreohelix*. Two lots supplied by Professor Henderson, one from Franklin Butte west of Franklin, Idaho (7 sp.), and one from "east of Webster, Utah, sta. 39" (6 sp.), are much lighter in color. Those from the last locality are larger than any of Hemphill's *fragilis*. The dark brown color and the nature of the bands indicate a strong possibility that Hemphill's shells are a small race of *Anguispira*. Except for the small size, the thinness of the shells, and the absence of bands on some specimens we would hesitate to separate them more than subspecifically from *A. kochi*.

Professor Henderson's shells seem unquestionably specifically distinct from Hemphill's *fragilis* and the true generic relationship of the latter can probably only be stated when living material shall have been collected and dissected.

A small lot of a very pretty chestnut-brown colored *Oreohelix* close to *O. fragilis* was found by one of us (A. G. S.) in 1931 in rock slides in the valley of the Clearwater River, 12 miles south of Lewiston, Idaho. Many specimens in the lot were broken about the spire owing to the thinness of the shells, probably the work of rodents.

### 4. **Oreohelix variabilis** Henderson

Plate 36, figures 7, 8, 9

*Patula strigosa castaneus* Hemphill [in part], Binney, 2nd Suppl. Terr. Moll. **5**, (Bull. Mus. Comp. Zool. Harvard College, **13**, 2), 1886, p. 32.—Pilsbry, Man. Conch. ser. 2, **8**:116, 1893, pl. 41, figs. 84–85.

*Oreohelix variabilis* Henderson, Proc. Calif. Acad. Sci., ser. 4, **18**, 8:221–226, Apr. 5, 1929, pl. 24, figs. 2–4; "near Celilo, Oregon."

*Oreohelix strigosa variabilis* Henderson, Pilsbry, Proc. Acad. Nat. Sci. Philadelphia, **85**:387–390, 1934, pl. 14, figs. 25, 26, text fig. 7.

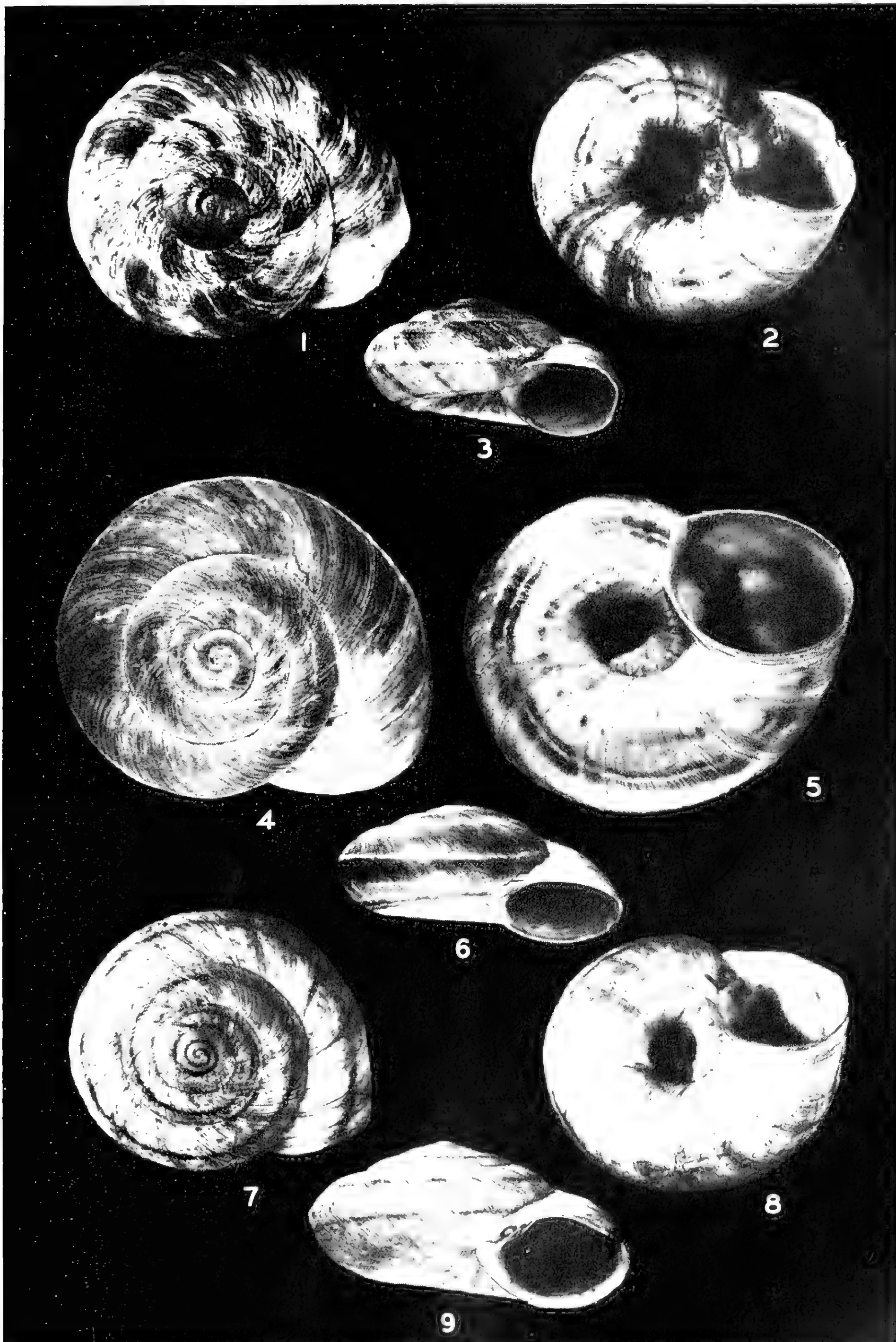
Henderson has supplied all the information there is available regarding Hemphill's collections of this species. In the 1931 collections more than 400 specimens were obtained (by A. G. S.) among grass and under brush and stones on the Sherman County highway, southeast of Biggs, Oregon, which is on the Columbia River Highway about 20 miles east of The Dalles. As there had been a heavy rain the day before, the snails were on the surface in large numbers.

*Variabilis* is well named, being exceedingly variable in both size of shell and in coloration, which ranges from a whitish buff with hardly any darker color, to a deep brown with almost no lighter color. It is normally a maculated shell, the chestnut-brown color appearing as small flecks, as a discontinuous cloudiness, or in a few shells, as a general suffusion over both the upper and the lower surface. Generally the shells are bandless, although distinct narrow bands are found on the bases of a few of the darker shells. Suggestion of bands is rarely seen on the upper surface.

When found, nearly all of the animals contained fully matured young ranging from 5 to 15 in each shell. The entire lot was kept alive for several months and hundreds of young were born in the meantime. The newly-born young consist of about two whorls, all uniformly dark chestnut in color, strongly carinate, somewhat planulate above, and measure from 3.7 to 4.5 mm. in diameter, the larger ones being in the smaller clutches of young. Sculpture consists of fairly coarse growth-ribs on which are superimposed many fine, rather wavy, closely spaced spiral lines covering the entire two turns. These spiral lines are either obsolete, or lacking entirely on the later whorls of adult shells.

Another small lot of *variabilis* was collected in rock slides in the Columbia River Valley about three miles above Biggs. These were smaller and darker than those in the first lot.

The diam. of 20 of the first mentioned lot varies from 15.3 mm. to 21.3 mm. and the alt. from 10.0 mm. to 15.2 mm., the average being diam. 18.9 mm., alt. 12.9 mm.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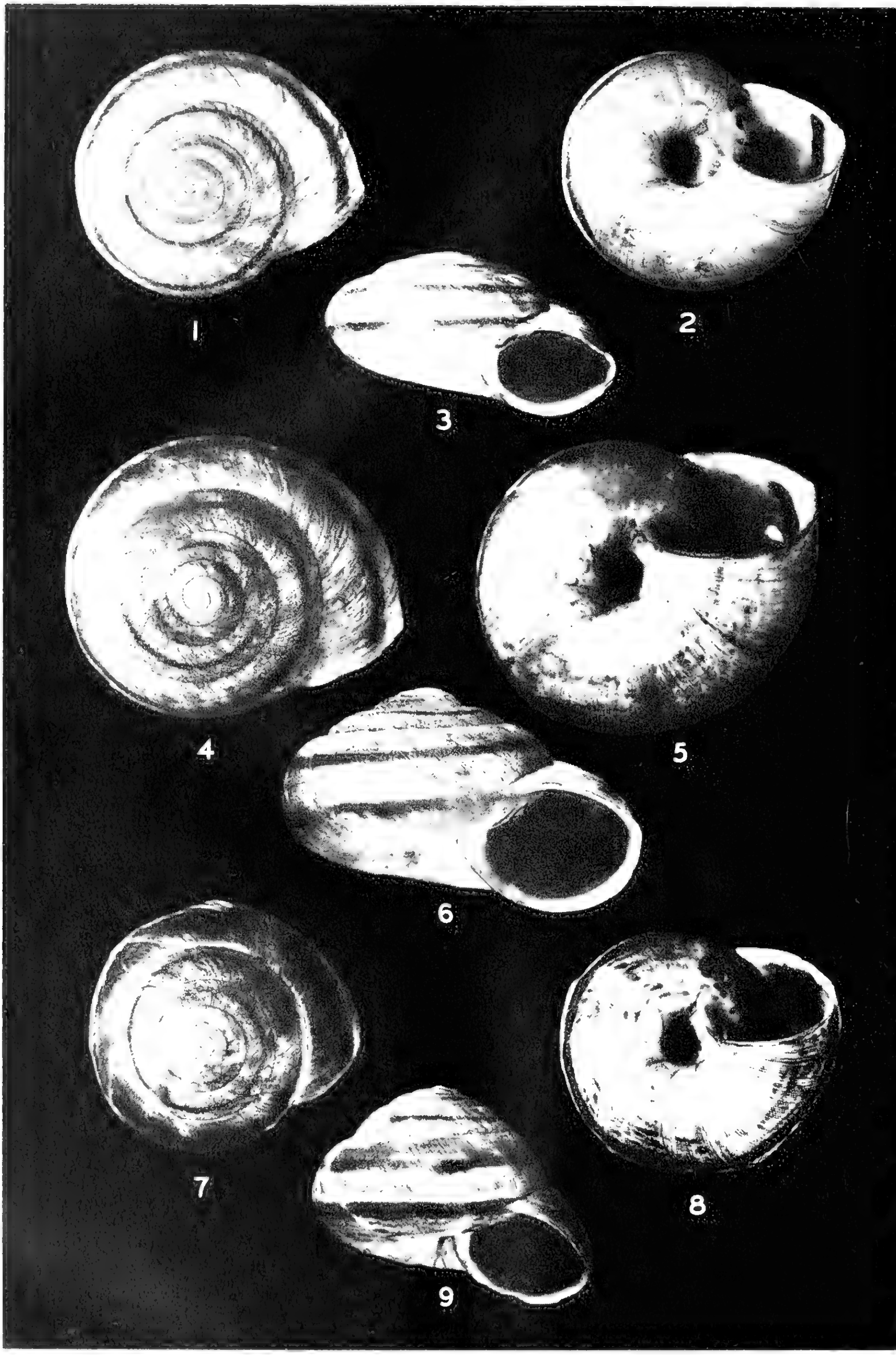
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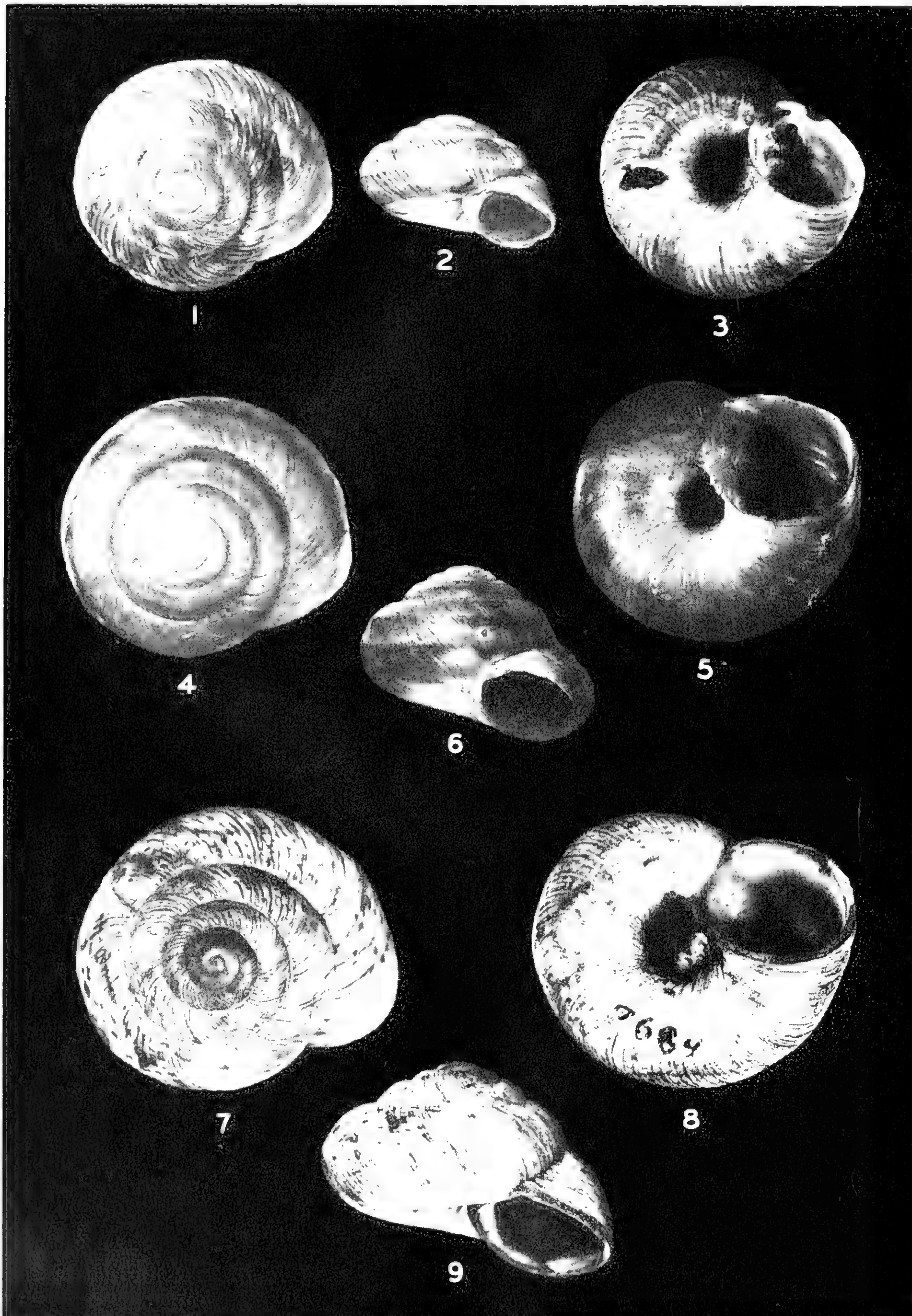
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## Plate 33

Figs. 1, 2, 3. *Oreohelix strigosa* (Gould). Hypotype No. 5843 (C. A. S.), Entiat, Washington. Diameter, 21.5 mm.; altitude, 11.0 mm. This specimen is close to the type; pp. 383-384.

Figs. 4, 5, 6. *Oreohelix strigosa* (Gould). Hypotype No. 5844 (C. A. S.), 4 miles north of Entiat, Washington. Diameter, 23.7 mm.; altitude, 11.4 mm.; p. 383.

Figs. 7, 8, 9. *Oreohelix strigosa* (Gould). Syntype No. 5225 (C. A. S.) of *Patula strigosa parma* Hemphill; near Spokane, Washington; original No. 7625 (H. H.). Diameter, 27.0 mm.; altitude, 13.7 mm.; p. 387.

Figures 1–3 and 6–9 from photographs by G. D. Hanna; figures 4 and 5 from photographs by A. E. Burns of the Pacific Telephone and Telegraph Co., San Francisco.

## Plate 34

Figs. 1, 2, 3. *Oreohelix strigosa* (Gould). Syntype No. 5226 (C. A. S.) of *Patula strigosa parma* Hemphill; near Spokane, Washington; original No. 7625 (H. H.). Diameter, 25.0 mm.; altitude, 13.0 mm.; p. 387.

Figs. 4, 5, 6. *Oreohelix strigosa* (Gould). Syntype No. 5229 (C. A. S.) of *Patula strigosa subcarinata* Hemphill; Rathdrum, Idaho; original No. 7631 (H. H.). Diameter, 29.5 mm.; altitude, 18.0 mm.; p. 385.

Figs. 7, 8, 9. *Oreohelix strigosa* (Gould). Syntype No. 5629 (C. A. S.) of *Patula strigosa picta* Hemphill; Rathdrum, Idaho; original No. 7630 (H. H.). Diameter, 24.2 mm.; altitude, 17.3 mm.; p. 388.

All figures from photographs by G. D. Hanna.

## Plate 35

Figs. 1, 2, 3. *Oreohelix strigosa* (Gould). Syntype No. 5228 (C. A. S.) of ***Patula strigosa jugalis*** Hemphill; Salmon River Mountain, Idaho; original No. 7701 (H. H.). Diameter, 22.0 mm.; altitude, 12.8 mm.; p. 385.

Figs. 4, 5, 6. *Oreohelix strigosa* (Gould). Lectotype No. 5625 (C. A. S.) of *Patula strigosa lactea* Hemphill; Rathdrum, Idaho; original No. 7637 (H. H.). Diameter, 28.3 mm.; altitude, 20.5 mm.; p. 387.

Figs. 7, 8, 9. *Oreohelix strigosa* (Gould). Lectotype No. 5626 (C. A. S.) of *Patula strigosa bicolor* Hemphill; Rathdrum, Idaho; original No. 7635 (H. H.). Diameter, 27.6 mm.; altitude 19.7 mm.; p. 386.

All figures from photographs by G. D. Hanna.

## Plate 36

Figs. 1, 2, 3. *Oreohelix intersum* (Hemphill). Lectotype No. 5628 (C. A. S.) of *Patula strigosa intersum* Hemphill; Little Salmon River, Idaho; original No. 7617 (H. H.). Diameter, 17.7 mm.; altitude, 11.0 mm.; p. 388.

Figs. 4, 5, 6. "*Oreohelix*" *fragilis* (Hemphill). Lectotype No. 5227 (C. A. S.) of *Patula strigosa fragilis* Hemphill; Franklin, Idaho; original No. 7660 (H. H.). Diameter, 19.9 mm.; altitude, 14.5 mm.; p. 389.

Figs. 7, 8, 9. *Oreohelix variabilis* Henderson. Holotype No. 2987 (C. A. S.) and lectotype of "*Patula strigosa castaneus*" Hemphill; "near Celilo, Oregon." Diameter, 22.0 mm.; altitude, 15.5 mm.; p. 390.

All figures from photographs by G. D. Hanna.

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No. 26

# NOTES ON A COLLECTION OF REPTILES AND AMPHIBIANS FROM GUATEMALA*

## I. SNAKES

BY

JOSEPH R. SLEVIN

*Curator, Department of Herpetology*
*California Academy of Sciences*

The following paper is based on a collection of snakes made in Guatemala during the spring of 1924 and of 1926, when the author in company with Mr. A. W. Anthony, veteran ornithologist well known for his work on the west coasts of America and Mexico, was making his initial efforts at gathering a representative collection of Guatemalan birds[1].

The field operations pertaining to this paper included the various zones from sea level to 10,000 feet, though much of the work was done about the 2,000 foot level. The line of the railroad was followed from San Jose, on the west coast, to Puerto Barrios on the east, while side trips were made both to the north and south of it. The most productive territory proved to be about the 2,000 foot level in the coffee belt that had been long under cultivation, although a zone just above the 8,000 foot level where there had been some cut-

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[1] This collection, now known as the Dwight collection, is housed in the American Museum of Natural History and is the finest in America, being exceeded only by the Salvin-Godman collection in the British Museum of Natural History.

December 29, 1939

ting of timber was found, despite the elevation, to harbor a considerable snake population.

For the many courtesies received during the two field trips to Guatemala my thanks are due the Honorable Philip Holland, at that time United States Consul General to Guatemala, whose assistance was most valuable in securing the necessary Government permits, to Señor Juan Zenon Posadas whose hospitality I enjoyed at his coffee plantation on the slopes of the Volcan Zunil, where the greater part of the collection was made, and last but not least to my companion Mr. A. W. Anthony whose field experience proved invaluable during our travels, and who very kindly furnished the photographs for the plates in this paper.

All the localities visited on the two expeditions are given in the present paper, which may be referred to in connection with the account of the lizards and amphibians to be published at a future date.

## Localities Visited

*El Potrero Finca, Sacatepequez Province.*—Altitude 5,000 feet. A coffee plantation situated at the base of the Volcan Agua and adjacent to the village of Puebla Vieja. Much of the surrounding country was cleared for cultivation and was planted in sugar cane and coffee. The sides of the Volcan Agua were covered with the corn fields of the Indians to an elevation of some 7,000 feet, where a well-defined line of rain forest began, forming an impenetrable growth and reaching well up towards the summit. From this finca visits were made to the village of San Antonio not far from Duenas, and some collecting was done about a small lake known as Lake Duenas or Lake San Antonio. The surrounding country had been cleared for cultivation and the rock walls dividing the various fields made excellent reptile cover. May 12–June 8, 1924.

*Quirigua, Izabal Province.*—Altitude 150 feet. A small town about sixty miles inland from Puerto Barrios in the low humid belt of the Montagua Valley. Collections were made on the Puebla and Nahua ranches of the United Fruit Company. Most of the land was given over to the cultivation of bananas, though there was some virgin forest and partly cleared land. June 14–26, 1924.

*Progreso or Cuastatoya, Jalapa Province.*—Altitude 2,000 feet. A small town in the arid belt of the upper Montagua Valley. The surrounding country reminds one of parts of the western American deserts, with several species of cacti and many trees similiar to the mesquite. Bottom lands cut up by many arroyos, and a number of roads and trails bordered by cactus fences. July 2–14, 1924.

*Finca El Cipres, Suchitepequez Province.*—Altitude 2,000 feet. A coffee plantation near the village of Samayac on the southern base of the Volcan Zunil. Much of the original forest was left to shade the coffee trees and some open grass land between the plantation and the base of the mountain proper. While at Finca El Cipres the Ixtacapa River in the vicinity of Samayac was visited. The Ixtacapa is a fair sized stream running through a deep gorge, the sides of which are covered with a dense undergrowth. July 9–Aug. 29, 1924 and May 25–July 3, 1926.

*Finca Salache, Suchitepequez Province.*—Altitude about 1,000 feet. A small coffee plantation about one mile west of Mazatenango. Much of the original rain forest remains and several streams run through the plantation. July 30 and Aug. 8, 1924.

*Finca La Colonia, Suchitepequez Province.*—Altitude about 1,500 feet. A plantation on the lower slopes of the Volcan Zunil. Some clearings planted in coffee, with original rain forest shade trees, but principally given over to the growing of sugar cane. August 13 and 15, 1924.

*Champerico, Retalhuleu Province.*—Sea level. Open grass land, mangrove swamps and lagoons. Inland from the lagoons are some areas of virgin forest cut up by roads and trails. August 20, 1924.

*Mazatenango, Suchitepequez Province.*—Altitude about 1,000 feet. Hilly country of virgin rain forest and coffee clearings. Many streams and numerous trails and roads through forested areas. July 30, 1924.

*Los Patos River, Suchitepequez Province.*—Altitude about 300 feet. Collections were made at a rancheria about fourteen miles above the mouth. Low coastal country with virgin forest and some clearings, given over to cattle raising on a small scale. June 18–23, 1926.

*Tecpan, Chimaltenango Province.*—Altitude about 8,000 feet. A highland town about sixty miles north of Guatemala City. Open rolling plateau planted in corn. July 6, 1926.

*Chichivac, Chimaltenango Province.*—Altitude about 8,650 feet. A hacienda about three miles north of the town of Tecpan. Forests of oak, pine and alder, with some open ridge country. July 14–Aug. 16, 1926.

*Santa Elena, Chimaltenango Province.*—Altitude about 10,000 feet. A sawmill and hacienda about six miles to the westward of Chichivac. Heavy cypress forests and trees covered with much moss and other plant life. Some roads and trails through the forest, crossing over some open ridge country. July 31 and Aug. 2, 1926.

### **Constrictor constrictor imperator** (Daudin)

This species was found to inhabit both the dry and the humid belts, one, No. 67046, being taken in the front garden of the ranch house at Nahua, Quirigua, where it was found under a banana tree in the act of swallowing a full-grown chicken, which it had just killed, and another, No. 67047, being taken in the dry area at Progreso. Two, Nos. 66955 and 66969, are from Finca El Cipres, Volcan Zunil. The Indians report this species as abundant and several other individuals were seen but not taken owing to the scarcity of alcohol and tank space.

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* |
|---|---|---|---|---|---|---|---|
| 67046 | ♀ | 67 | 247 | 52c | 1 | 19–18 | 22–22 |
| 67047 | ♂ | 69 | 262 | 55c | 1 | .......... | .......... |
| 66955 | ♂ | 63 | 229 | 61c | 1 | 17–18 | 20–20 |
| 66969 | ♂ | 57 | 236 | 57c | 1 | 18–18 | 21–23 |

### **Sibynophis annulatus** (Duméril and Bibron)

Two specimens of this peculiarly marked snake taken at the edge of a clearing amongst the coffee trees at Finca El Cipres have the following scale counts:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Tem-porals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66967 | ♂ | 17 | 142 | 108+ | ÷ | 9–9 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2−1+2 |
| 66968 | ♀ | 17 | 152 | 100+ | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2−1+2 |

Both specimens are somewhat similiar in coloration. The top of the head is black, with a dark grayish transverse band between the eyes. At the base of the parietals begins a series of black bands, divided by one or two rows of grayish scales, and separated from each other by a band of red, nine to ten scales wide. The black bands break posteriorly, forming blotches on a ground color of red. This coloration forms the anterior third of the body, while the remainder is grayish or olive, with or without three longitudinal rows of black spots. Under surfaces yellowish-white, the gastrosteges and urosteges with lateral grayish spots. No. 66968, the female, lacks the posterior spotting and is uniform olive in coloration.

## **Thamnophis eques** (Reuss)

This species is represented by 26 specimens as follows: nine, Nos. 66974–66982, from Chichivac in the vicinity north of Tecpan; sixteen, Nos. 66983–66998, from Lake San Antonio in the vicinity of the town of San Antonio; one, No. 66973, from El Potrero Finca, Volcan Agua.

At Chichivac they were found under slabs of bark in moist situations, and at Lake San Antonio amongst the tules along the lake shore. The single specimen from Volcan Agua was taken in an irrigation ditch. The stomachs of the Lake San Antonio snakes were found to contain tadpoles; probably of *Rana pipiens*, an abundant species in that region. *Thamnophis eques* is apparently a highland species as it was not found below 4,500 feet.

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastrosteges* | *Urosteges* | *Anal* | *Supralabials* | *Infralabials* | *Preoculars* | *Postoculars* | *Loreal* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66973 | ♂ | 19–19–17 | 150 | 52+ | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+1−1+1 |
| 66974 | ♀ | 19–19–17 | 147 | 60c | 1 | 9–8 | 9–10 | 1–1 | 3–3 | 1–1 | 1+2−1+2 |
| 66975 | ♀ | 19–19–17 | 148 | 66c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+2 |
| 66976 | ♂ | 19–19–17 | 144 | 71c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+2 |
| 66977 | juv. | 19–19–17 | 150 | 72c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+3 |
| 66978 | ♂ | 19–19–17 | 151 | 54+ | 1 | 8–8 | 10–10 | 1–1 | 3–2 | 1–1 | 1+3−1+2 |
| 66979 | ♂ | 19–19–17 | 148 | 63c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+3 |
| 66980 | juv. | 19–19–17 | 143 | 63c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+2 |
| 66981 | juv. | 19–19–17 | 145 | 74c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+2 |
| 66982 | ♀ | 19–19–17 | 145 | 59c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+2 |
| 66983 | ♀ | 19–19–17 | 144 | 60c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+3−1+2 |
| 66984 | ♀ | 19–19–17 | 144 | 61c | 1 | 8–8 | 10–11 | 1–1 | 3–3 | 1–1 | 1+3−1+3 |
| 66985 | ♂ | 19–19–17 | 147 | 68+ | 1 | 8–8 | 10–10 | 2–1 | 3–3 | 1–1 | 1+3−1+3 |
| 66986 | ♂ | 19–19–17 | 153 | 70c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+2 |
| 66987 | ♀ | 19–19–17 | 142 | 66c | 1 | 8–8 | 9–10 | 1–1 | 4–4 | 1–1 | 1+3−1+3 |
| 66988 | ♂ | 19–19–17 | 142 | 76c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+2 |
| 66989 | ♀ | 19–19–17 | 147 | 63c | 1 | 9–9 | 10–10 | 1–1 | 4–3 | 1–1 | 1+3−1+3 |
| 66990 | ♀ | 19–19–17 | 142 | 62c | 1 | 8–8 | 11–11 | 1–1 | 3–3 | 1–1 | 1+2−1+2 |
| 66991 | ♀ | 19–19–17 | 142 | 70c | 1 | 8–8 | 11–11 | 1–1 | 3–3 | 1–1 | 1+3−1+3 |
| 66992 | ♂ | 19–19–17 | 147 | 72c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+2 |
| 66993 | ♀ | 19–19–17 | 143 | 62c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+4 |
| 66994 | ♂ | 19–19–17 | 146 | 55+ | 1 | 8–8 | 10–10 | 2–2 | 3–3 | 1–1 | 1+2−1+2 |
| 66995 | ♂ | 19–19–17 | 148 | 65+ | 1 | 9–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+2 |
| 66996 | ♂ | 19–19–17 | 149 | 71c | 1 | 8–8 | 9–11 | 1–1 | 3–3 | 1–1 | 1+3−1+3 |
| 66997 | ♀ | 19–19–17 | 140 | 63c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+2−1+3 |
| 66998 | ♂ | 19–19–17 | 145 | 71c | 1 | 8–8 | 10–10 | 1–1 | 3–3 | 1–1 | 1+3−1+3 |

## **Ninia sebæ** (Duméril and Bibron)

Twenty-one specimens from Finca El Cipres were taken from piles of earth and leaves which had been scraped together when the undergrowth was cleared from about the coffee trees. Owing to the rapidity with which vines and weeds grow in the coffee country it is necessary to keep the Indians constantly at work clearing the cafetals. In doing so the debris is gathered together into small piles mixed with earth, and when the leaves rot and the piles settle down till they become somewhat firm, they make excellent cover, and several species of snakes were found to inhabit them[2].

All of the snakes in this series are reddish above in coloration, with the characteristic yellow collar followed by a black one, and all show the black cross bars, though in some individuals these bars are broken into blotches.

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Tem-porals* |
|---|---|---|---|---|---|---|---|---|---|---|
| 66870 | ♀ | 19 | 139 | 52c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66871 | ♂ | 19 | 138 | 57c | 1 | 7–7 | 7–8 | 1–1 | 2–2 | 1+2–1+2 |
| 66872 | juv. | 19 | 137 | 46c | 1 | 7–7 | 7–6 | 1–1 | 2–2 | 1+2–1+2 |
| 66873 | ♂ | 19 | 130 | 56c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66874 | ♀ | 19 | 139 | 52c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66875 | juv. | 19 | 125 | 57c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66876 | ♀ | 19 | 137 | 46c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66877 | ♂ | 19 | 131 | 57c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66878 | juv. | 19 | 131 | 60c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66879 | ♀ | 19 | 133 | 49c | 1 | 7–7 | 7–7 | 1–1 | 2–1 | 1+2–1+2 |
| 66880 | ♂ | 19 | 133 | 62c | 1 | 7–7 | 7–8 | 1–1 | 2–2 | 1+2–1+2 |
| 66881 | ♀ | 19 | 132 | 47c | 1 | 7–7 | 7–7 | 1–1 | 1–2 | 1+2–1+2 |
| 66882 | ♂ | 19 | 133 | 57c | 1 | 7–7 | 7–7 | 1–1 | 1–2 | 1+2–1+2 |
| 66883 | juv. | 19 | 131 | 56c | 1 | 7–7 | 7–6 | 1–1 | 1–2 | 1+2–1+2 |
| 66884 | juv. | 19 | 128 | 52c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66885 | juv. | 19 | 122 | 47c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66886 | juv. | 19 | 131 | 59c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66887 | ♀ | 19 | 137 | 44+ | 1 | 7–7 | 7–7 | 1–1 | 1–1 | 1+2–1+2 |
| 66888 | ♂ | 19 | 135 | 51+ | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66889 | ♀ | 19 | 137 | 50c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |
| 66890 | ♀ | 19 | 136 | 50c | 1 | 7–7 | 7–7 | 1–1 | 2–2 | 1+2–1+2 |

## **Eudryas dorsalis** (Bocourt)

Two specimens of this distinctive highland form were taken; one No. 67002, from Volcan Agua, and one, No. 67003, from San Antonio. Both were found in open fields close to rock fences, and both are of the typical green coloration, with the characteristic dorsal and lateral stripes quite prominent.

[2] See Plate No. 1, Fig. 1, for list of species found to inhabit this type of cover.

Scale counts are as follows:

| Number | Sex | Scale Rows | Gastro-steges | Uro-steges | Anal | Supra-labials | Infra-labials | Pre-oculars | Post-oculars | Loreal | Tem-porals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 67002 | ♀ | 17 | 199 | 132c | ÷ | 9–9 | 11–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 67003 | ♂ | 17 | 191 | 122+ | ÷ | 9–8 | 10–11 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |

## **Eudryas slevini** (Stuart)

This name is applied to three specimens, Nos. 66946–66948, from Finca El Cipres. The dorsal coloration is uniform bluish-gray. The underfaces are uniform yellowish, the throat being marbled with bluish-gray. All three snakes were taken in the cleared areas amongst the coffee trees.

Scale counts are as follows:

| Number | Sex | Scale Rows | Gastro-steges | Uro-steges | Anal | Supra-labials | Infra-labials | Pre-oculars | Post-oculars | Loreal | Tem-porals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66946 | ♀ | 17 | 187 | 109+ | ÷ | 9–10 | 11–11 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 66947 | ♀ | 17 | 186 | 104c | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 66948 | ♀ | 17 | 185 | 107c | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |

## **Drymobius margaritiferus** (Schlegel)

One of the more common species met with, and ranging in elevation from about 150 feet to 5,000 feet. Apparently it does not confine itself to any particular type of habitat, as individuals were taken in the open country of the grassy highlands, amongst the coffee trees at the 2,000 foot level, and in the low, humid areas of the Montagua Valley. The series includes three specimens, Nos. 67004–67006, from San Antonio; two Nos. 67007 and 67009, from Quirigua, and nine, Nos. 66928–66936, from Finca El Cipres, Volcan Zunil. The green and yellow scales, with their black borders, make this snake quite conspicuous, even in a somewhat heavy undergrowth.

Scale counts are as follows:

| Number | Sex | Scale Rows | Gastro-steges | Uro-steges | Anal | Supra-labials | Infra-labials | Pre-oculars | Post-oculars | Loreal | Tem-porals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66928 | ♂ | 17 | 145 | 127c | ÷ | 9–9 | 9–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 66929 | ♀ | 17 | 150 | 95+ | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 66930 | ♂ | 17 | 146 | 127c | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 66931 | ♀ | 17 | 146 | 125c | ÷ | 7–8 | 9–9 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 66932 | ♂ | 17 | 146 | 136c | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 66933 | ♂ | 17 | 150 | 125c | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 66934 | ♂ | 17 | 148 | 129c | ÷ | 9–9 | 10–x | 1–1 | 2–2 | x–1 | 2+2–2+2 |
| 66935 | ♀ | 17 | 146 | 127c | ÷ | 9–9 | 9–9 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 66936 | ♂ | 17 | 145 | 129c | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 67004 | ♂ | 17 | 152 | 45+ | ÷ | 9–9 | 11–11 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 67005 | ♂ | 17 | 154 | 116c | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 67006 | ♂ | 17 | 152 | 119c | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 67007 | ♀ | 17 | 151 | 107+ | ÷ | 9–9 | 9–9 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 67009 | ♂ | 17 | 156 | 119c | ÷ | 9–9 | 10–9 | 1–1 | 3–2 | 1–1 | 2+2–2+2 |

## **Drymarchon corais melanurus** (Duméril and Bibron)

Two specimens, Nos. 66970–66971, from Finca El Cipres, Volcan Zunil, have the following scale counts:

| Number | Sex | Scale Rows | Gastro-steges | Uro-steges | Anal | Supra-labials | Infra-labials | Pre-oculars | Post-oculars | Loreal | Tem-porals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66970 | x | 17 | 201 | 20+ | 1 | 8–8 | 8–9 | 1–1 | 2–2 | 1–1 | 2+1–2+1 |
| 66971 | ♀ | 17 | 203 | 61+ | 1 | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |

No. 66970 was dug out of a rotten stump in a small clearing amongst the trees of the original rain forest.

## **Pituophis lineaticollis** (Cope)

A single specimen, a male, No. 66972, taken on the western slope of the Volcan Agua at about 5,900 feet, has scales in 27 rows, gastrosteges 246, urosteges 65c, anal single, supralabials 8–8, infralabials 10–10, preoculars 1–1, postoculars 3–2, loreals 1–1, temporals 2–3.

This snake was found in a small corn field and dug out of a stump in which it had taken refuge.

### **Leptophis mexicanus** (Duméril and Bibron)

One specimen, found crawling about the edge of a pile of rotting banana leaves near Quirigua, has scale counts as follows:

Scale rows 15, gastrosteges 161, urosteges 162+, anal divided, supralabials 8–8, infralabials 10–10, preoculars 1–1, postoculars 2–2, loreal 1–1, temporals 1+2−1+2.

Probably the excellent type of cover the banana plantations afford made this more or less common species difficult to find, as only a single specimen was seen during twelve days intensive hunting.

### **Liophis godmani** (Gunther)

Six specimens, Nos. 67020–67025, of this distinctive little snake, were taken at Chichivac under old boards remaining from a dismantled sawmill. All show the typical dark-brown head and yellow spotted labials.

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Tem-porals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 67020 | ♂ | 21 | 172 | 93c | ÷ | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2−1+2 |
| 67021 | ♂ | 21 | 169 | 93c | ÷ | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2−1+3 |
| 67022 | ♂ | 21 | 167 | 88c | ÷ | 8–8 | 8–8 | 1–1 | 2–2 | 1–1 | 1+2−1+2 |
| 67023 | ♂ | 21 | 172 | 88+ | ÷ | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2−1+2 |
| 67024 | ♀ | 21 | 173 | 83c | ÷ | 8–8 | 9–8 | 1–1 | 2–2 | 1–1 | 1+2−1+2 |
| 67025 | ♂ | 21 | 169 | 91c | ÷ | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2−1+2 |

### **Liophis lachrymans** (Cope)

This species, together with *L. godmani* was found only in the highlands. Four specimens, Nos. 67016–67019, were taken at Chichivac under old boards and pieces of bark. The chestnut dorsal coloration and heavy black lateral bands, as well as the head markings, easily distinguish this species from *L. godmani.*

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Tem-porals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 67016 | ♂ | 17 | 165 | 86c | ÷ | 8–8 | 8–9 | 1–1 | 2–2 | 1–1 | 1+2−1+2 |
| 67017 | ♀ | 17 | 180 | 72+ | ÷ | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2−1+2 |
| 67018 | juv. | 17 | 167 | 83c | ÷ | 8–8 | 9–9 | 1–1 | 3–2 | 1–1 | 1+1−1+1 |
| 67019 | juv. | 17 | 163 | 80c | ÷ | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2−1+2 |

## **Xenodon colubrinus** (Gunther)

Eight specimens from Finca El Cipres, Volcan Zunil, were dug out of piles of earth in the cafetals.

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Tem-porals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66920 | ♀ | 19 | 136 | 40+ | 1 | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 66921 | ♂ | 19 | 137 | 44c | 1 | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 66922 | ♂ | 19 | 129 | 40c | 1 | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 66923 | ♂ | 19 | 133 | 44c | 1 | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 66924 | ♀ | 19 | 141 | 36+ | 1 | 9–9 | 9–9 | 1–1 | 2–2 | 1–1 | 1+3–1+2 |
| 66925 | ♀ | 19 | 141 | 41+ | 1 | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 66926 | ♂ | 19 | 142 | 39+ | 1 | 8–8 | 9–10 | 1–1 | 3–3 | 1–1 | 1+2–1+2 |
| 66927 | ♂ | 19 | 134 | 41c | 1 | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |

## **Urotheca elapoides elapoides** (Cope)

Seven specimens of this brightly black, red, and yellow banded snake are from Finca El Cipres, Volcan Zunil. The Indians do not distinguish this snake from the coral snake, which they know to be venomous, and they could not be induced to handle one.

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Tem-porals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66910 | ♀ | 17 | 129 | 66+ | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+1–1+1 |
| 66911 | ♂ | 17 | 128 | 115c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+1–1+1 |
| 66912 | ♂ | 17 | 124 | 79+ | ÷ | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+1–1+1 |
| 66913 | x | 17 | 132 | 8+ | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+1–1+2 |
| 66914 | ♀ | 17 | 132 | 99+ | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+1–1+1 |
| 66915 | x | 17 | 137 | 6+ | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+1–1+1 |
| 66916 | ♂ | 17 | 123 | 57+ | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |

## **Trimetopon posadasi** (Slevin)

Five specimens of this snake, Nos. 66962–66966, were taken at Finca El Cipres, Volcan Zunil. The description of the type, No. 66964, Mus. Calif. Acad. Sci., and the scale counts of the remaining specimens, together with those of a specimen, No. 20420, Field

Museum of Natural History, Chicago, are given in the Proc. Calif. Acad. Sci., Ser. 4, Vol. XXIII, No. 4, pp. 79–81. It is believed that this series represents all the specimens now known from Guatemala.

### **Adelphicos quadrivirgatus** (Jan)

This proved to be an abundant species at Finca El Cipres, Volcan Zunil, where the entire series of 145 specimens, Nos. 66725–66869 was dug out of piles of debris in the cafetals. The series shows little if any variation in color, the reddish-brown ground color, with blackish longitudinal lines, being constant throughout. All have scales in 15 rows, anal divided, supralabials 7–7, infralabials 7–7, loreal 1–1, postoculars 2–2, temporals 1+1—1+1.

Sexes and variations in scale counts are as follows:

| *Number* | *Sex* | *Gastrosteges* | *Urosteges* | *Number* | *Sex* | *Gastrosteges* | *Urosteges* | *Number* | *Sex* | *Gastrosteges* | *Urosteges* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66725 | juv. | 129 | 28c | 66757 | ♂ | 126 | 26c | 66789 | ♂ | 132 | 30c |
| 66726 | juv. | 135 | 27c | 66758 | ♀ | 139 | 28c | 66790 | ♀ | 135 | 23c |
| 66727 | ♂ | 125 | 32c | 66759 | ♂ | 120 | 30c | 66791 | ♂ | 131 | 31c |
| 66728 | juv. | 125 | 30c | 66760 | juv. | 138 | 20c | 66792 | ♀ | 134 | 25c |
| 66729 | juv. | 124 | 21+ | 66761 | ♀ | 142 | 26c | 66793 | ♂ | 128 | 22c |
| 66730 | ♀ | 136 | 26c | 66762 | juv. | 121 | 22c | 66794 | ♀ | 137 | 22c |
| 66731 | juv. | 126 | 24c | 66763 | ♀ | 134 | 26c | 66795 | ♂ | 131 | 28c |
| 66732 | ♀ | 135 | 26c | 66764 | ♂ | 127 | 29c | 66796 | ♂ | 127 | 24c |
| 66733 | ♂ | 126 | 30c | 66765 | ♀ | 128 | 28c | 66797 | ♀ | 138 | 26c |
| 66734 | ♀ | 142 | 30c | 66766 | ♂ | 129 | 28c | 66798 | ♀ | 136 | 26c |
| 66735 | juv. | 131 | 24c | 66767 | ♂ | 127 | 33c | 66799 | juv. | 130 | 28c |
| 66736 | ♀ | 137 | 22c | 66768 | ♀ | 136 | 26c | 66800 | juv. | 121 | 27c |
| 66737 | juv. | 131 | 22c | 66769 | ♂ | 127 | 33c | 66801 | ♂ | 126 | 32c |
| 66738 | juv. | 124 | 28c | 66770 | ♂ | 128 | 29c | 66802 | ♀ | 139 | 26c |
| 66739 | ♂ | 129 | 32c | 66771 | ♂ | 122 | 30c | 66803 | ♀ | 141 | 27c |
| 66740 | ♀ | 138 | 17+ | 66772 | ♀ | 138 | 26c | 66804 | juv. | 136 | 24c |
| 66741 | ♀ | 138 | 28c | 66773 | ♀ | 134 | 26c | 66805 | ♂ | 130 | 31c |
| 66742 | ♂ | 130 | 32c | 66774 | ♀ | 141 | 29+ | 66806 | ♂ | 127 | 30c |
| 66743 | ♂ | 126 | 26c | 66775 | ♀ | 143 | 27c | 66807 | ♂ | 129 | 35c |
| 66744 | ♂ | 128 | 27c | 66776 | ♀ | 134 | 25c | 66808 | ♂ | 122 | 29c |
| 66745 | ♂ | 126 | 34c | 66777 | ♂ | 126 | 31c | 66809 | ♀ | 139 | 23c |
| 66746 | ♂ | 123 | 31c | 66778 | ♀ | 124 | 28c | 66810 | ♂ | 126 | 26c |
| 66747 | ♀ | 140 | 23c | 66779 | ♂ | 123 | 31c | 66811 | juv. | 134 | 25c |
| 66748 | ♀ | 134 | 26c | 66780 | ♂ | 129 | 22c | 66812 | juv. | 125 | 27c |
| 66749 | ♂ | 125 | 32c | 66781 | ♀ | 138 | 26c | 66813 | ♀ | 139 | 26c |
| 66750 | ♂ | 124 | 34c | 66782 | ♀ | 141 | 23c | 66814 | ♀ | 141 | 27c |
| 66751 | ♂ | 128 | 29c | 66783 | ♂ | 125 | 30c | 66815 | ♂ | 127 | 32c |
| 66752 | juv. | 128 | 24c | 66784 | ♀ | 134 | 27c | 66816 | ♀ | 133 | 28c |
| 66753 | juv. | 132 | 23c | 66785 | ♀ | 136 | 24c | 66817 | ♀ | 135 | 26c |
| 66754 | ♂ | 129 | 32c | 66786 | juv. | 138 | 27c | 66818 | ♀ | 144 | 24c |
| 66755 | ♀ | 141 | 27c | 66787 | ♀ | 134 | 24c | 66819 | ♂ | 124 | 32c |
| 66756 | ♂ | 132 | 31c | 66788 | ♀ | 125 | 26c | 66820 | juv. | 125 | 27c |

| *Number* | *Sex* | *Gastro-steges* | *Uro-steges* | *Number* | *Sex* | *Gastro-steges* | *Uro-steges* | *Number* | *Sex* | *Gastro-steges* | *Uro-steges* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66821 | ♀ | 136 | 27c | 66838 | juv. | 131 | 29c | 66854 | ♀ | 136 | 26c |
| 66822 | ♂ | 126 | 30c | 66839 | juv. | 126 | 28c | 66855 | ♀ | 140 | 28c |
| 66823 | ♀ | 137 | 28c | 66840 | juv. | 129 | 33c | 66856 | ♀ | 147 | 26c |
| 66824 | ♂ | 129 | 29c | 66841 | ♀ | 143 | 27c | 66857 | ♂ | 129 | 35c |
| 66825 | ♀ | 135 | 24c | 66842 | ♀ | 140 | 25c | 66858 | ♀ | 141 | 24c |
| 66826 | ♂ | 130 | 28c | 66843 | ♂ | 134 | 32c | 66859 | ♂ | 129 | 33c |
| 66827 | ♂ | 128 | 30c | 66844 | ♀ | 142 | 27c | 66860 | ♂ | 129 | 26c |
| 66828 | juv. | 131 | 24c | 66845 | ♀ | 146 | 26c | 66861 | ♂ | 128 | 29c |
| 66829 | juv. | 129 | 25c | 66846 | ♂ | 127 | 31c | 66862 | ♂ | 128 | 30c |
| 66830 | juv. | 120 | 26c | 66847 | ♀ | 133 | 28c | 66863 | ♀ | 146 | 24+ |
| 66831 | ♂ | 126 | 29c | 66848 | ♂ | 131 | 29c | 66864 | ♂ | 133 | 30c |
| 66832 | juv. | 121 | 29c | 66849 | ♀ | 135 | 28c | 66865 | juv. | 136 | 25c |
| 66833 | ♂ | 129 | 32c | 66850 | ♂ | 129 | 33c | 66866 | ♀ | 137 | 23c |
| 66834 | ♀ | 139 | 27c | 66851 | juv. | 134 | 26c | 66867 | ♂ | 127 | 31c |
| 66835 | ♂ | 128 | 32c | 66852 | juv. | 129 | 30c | 66868 | ♂ | 127 | 31c |
| 66836 | ♀ | 135 | 27c | 66853 | ♂ | 131 | 30c | 66869 | ♂ | 136 | 33+ |
| 66837 | juv. | 124 | 26c | | | | | | | | |

## **Catostoma chalybeum** Wagler

The most common species found at Finca El Cipres, Volcan Zunil, 217 specimens having been dug out of piles of debris in the cafetals. The series shows practically no variation in coloration. Alcoholic specimens are a dark brown, but in life the dorsal coloration was silvery-gray, although occasionally a darker phase was met with, especially in the young. All have scales in 17 rows, anal single, supralabials 6–6, postoculars, 1–1, loreal 1–1. In 73 out of 124 males chin tubercles are present.

Sexes and variation in scale counts are as follows:

| *Number* | *Sex* | *Gastro-steges* | *Uro-steges* | *Infra-labials* | *Number* | *Sex* | *Gastro-steges* | *Uro-steges* | *Infra-labials* |
|---|---|---|---|---|---|---|---|---|---|
| 66508 | ♀ | 121 | 25c | 7–7 | 66518 | ♀ | 125 | 28c | 7–7 |
| 66509 | ♀ | 124 | 26c | 7–7 | 66519 | ♂ | 122 | 32c | 7–7 |
| 66510 | ♂ | 118 | 33c | 7–7 | 66520 | ♂ | 120 | 33c | 7–7 |
| 66511 | ♂ | 120 | 34c | 7–8 | 66521 | ♂ | 121 | 35c | 7–7 |
| 66512 | ♀ | 123 | 27c | 7–7 | 66522 | ♂ | 121 | 31c | 7–7 |
| 66513 | ♀ | 125 | 29c | 7–7 | 66523 | ♀ | 120 | 27c | 7–7 |
| 66514 | ♂ | 120 | 34c | 7–7 | 66524 | ♂ | 118 | 33c | 7–7 |
| 66515 | ♂ | 121 | 34c | 7–7 | 66525 | ♀ | 123 | 27c | 7–7 |
| 66516 | ♂ | 121 | 23+ | 7–7 | 66526 | ♀ | 125 | 27c | 7–7 |
| 66517 | ♂ | 119 | 33c | 7–7 | 66527 | ♂ | 122 | 33c | 7–7 |

| Number | Sex | Gastro-steges | Uro-steges | Infra-labials | Number | Sex | Gastro-steges | Uro-steges | Infra-labials |
|---|---|---|---|---|---|---|---|---|---|
| 66528 | ♂ | 121 | 32c | 7–7 | 66579 | ♂ | 123 | 30c | 7–7 |
| 66529 | ♂ | 121 | 33c | 7–7 | 66580 | ♂ | 122 | 32c | 7–7 |
| 66530 | ♂ | 119 | 33c | 7–7 | 66581 | ♂ | 121 | 31c | 7–7 |
| 66531 | ♀ | 121 | 26c | 7–7 | 66582 | ♀ | 126 | 29c | 7–7 |
| 66532 | ♂ | 125 | 31c | 7–7 | 66583 | ♂ | 119 | 34c | 7–7 |
| 66533 | ♂ | 122 | 33c | 7–7 | 66584 | ♂ | 121 | 32c | 7–7 |
| 66534 | ♀ | 124 | 26c | 7–7 | 66585 | ♂ | 123 | 32c | 7–7 |
| 66535 | ♀ | 127 | 26c | 7–7 | 66586 | ♀ | 123 | 26c | 7–7 |
| 66536 | ♀ | 130 | 29c | 7–7 | 66587 | ♂ | 121 | 28+ | 8–8 |
| 66537 | ♀ | 116 | 30c | 7–7 | 66588 | ♀ | 117 | 24c | 7–7 |
| 66538 | ♀ | 124 | 12+ | 7–7 | 66589 | ♂ | 118 | 32c | 7–7 |
| 66539 | ♂ | 119 | 33c | 7–7 | 66590 | ♂ | 121 | 32c | 7–7 |
| 66540 | ♀ | 125 | 28c | 7–7 | 66591 | ♀ | 123 | 24+ | 8–8 |
| 66541 | ♂ | 121 | 33c | 7–7 | 66592 | ♂ | 120 | 32c | 7–7 |
| 66542 | ♂ | 119 | 32c | 7–7 | 66593 | ♂ | 120 | 34c | 7–7 |
| 66543 | ♂ | 120 | 32c | 7–7 | 66594 | ♂ | 122 | 33c | 7–6 |
| 66544 | ♂ | 120 | 29c | 7–7 | 66595 | ♀ | 121 | 25+ | 7–8 |
| 66545 | ♂ | 119 | 32c | 7–7 | 66596 | ♂ | 119 | 34c | 7–8 |
| 66546 | ♂ | 120 | 32c | 7–7 | 66597 | ♂ | 122 | 34c | 7–7 |
| 66547 | ♀ | 117 | 25c | 8–8 | 66598 | ♂ | 122 | 30+ | 7–7 |
| 66548 | ♀ | 125 | 25c | 7–7 | 66599 | ♂ | 121 | 33c | 7–7 |
| 66549 | ♂ | 120 | 35c | 6–6 | 66600 | ♂ | 118 | 30c | 7–7 |
| 66550 | ♀ | 124 | 29c | 8–8 | 66601 | ♂ | 121 | 25+ | 7–7 |
| 66551 | ♀ | 120 | 26c | 7–7 | 66602 | ♂ | 120 | 34c | 7–7 |
| 66552 | ♀ | 122 | 26c | 7–7 | 66603 | ♀ | 123 | 28c | 7–7 |
| 66553 | ♂ | 123 | 33c | 7–7 | 66604 | ♀ | 123 | 27c | 7–7 |
| 66554 | ♀ | 121 | 25c | 7–7 | 66605 | ♂ | 118 | 32c | 6–6 |
| 66555 | ♀ | 126 | 27c | 7–7 | 66606 | ♂ | 117 | 32c | 7–7 |
| 66556 | ♀ | 123 | 27c | 7–7 | 66607 | ♀ | 119 | 27c | 7–7 |
| 66557 | ♀ | 126 | 27c | 7–7 | 66608 | ♀ | 126 | 26c | 8–8 |
| 66558 | ♂ | 127 | 32c | 7–7 | 66609 | ♂ | 119 | 33c | 7–7 |
| 66559 | ♂ | 122 | 31c | 7–7 | 66610 | ♀ | 119 | 24c | 7–7 |
| 66560 | ♀ | 124 | 26c | 7–7 | 66611 | ♂ | 120 | 32c | 8–8 |
| 66561 | ♂ | 122 | 34+ | 7–7 | 66612 | ♂ | 120 | 31c | 7–7 |
| 66562 | ♂ | 122 | 34c | 7–7 | 66613 | ♀ | 121 | 26c | 7–7 |
| 66563 | ♂ | 121 | 31c | 7–7 | 66614 | ♀ | 124 | 29c | 7–7 |
| 66564 | ♂ | 119 | 32c | 7–7 | 66615 | ♂ | 122 | 33c | 7–7 |
| 66565 | ♂ | 116 | 32c | 7–8 | 66616 | ♂ | 119 | 33c | 7–7 |
| 66566 | ♂ | 124 | 32c | 7–7 | 66617 | ♂ | 118 | 33c | 7–7 |
| 66567 | ♀ | 121 | 25c | 7–7 | 66618 | ♂ | 120 | 30c | 7–7 |
| 66568 | ♀ | 122 | 26c | 7–7 | 66619 | ♂ | 117 | 33c | 7–7 |
| 66569 | ♀ | 121 | 25c | 7–7 | 66620 | ♀ | 127 | 26c | 7–7 |
| 66570 | ♂ | 120 | 30c | 7–7 | 66621 | ♂ | 121 | 33c | 7–7 |
| 66571 | ♂ | 124 | 37c | 7–7 | 66622 | ♀ | 122 | 29c | 7–7 |
| 66572 | ♀ | 126 | 27c | 7–7 | 66623 | ♀ | 124 | 24c | 7–7 |
| 66573 | ♀ | 123 | 25c | 7–7 | 66624 | ♀ | 129 | 28c | 7–8 |
| 66574 | ♂ | 124 | 33c | 7–7 | 66625 | ♂ | 120 | 33c | 7–7 |
| 66575 | ♂ | 119 | 23c | 7–7 | 66626 | ♀ | 125 | 26c | 7–7 |
| 66576 | ♀ | 127 | 28c | 7–7 | 66627 | ♂ | 122 | 31c | 6–6 |
| 66577 | ♂ | 123 | 32c | 7–7 | 66628 | ♂ | 121 | 33c | 7–7 |
| 66578 | ♂ | 121 | 37c | 8–8 | 66629 | ♂ | 121 | 34c | 7–7 |

| *Number* | *Sex* | *Gastro-steges* | *Uro-steges* | *Infra-labials* | *Number* | *Sex* | *Gastro-steges* | *Uro-steges* | *Infra-labials* |
|---|---|---|---|---|---|---|---|---|---|
| 66630 | ♂ | 122 | 34c | 7–7 | 66678 | ♀ | 123 | 27c | 7–7 |
| 66631 | ♂ | 123 | 32c | 7–7 | 66679 | juv. | 125 | 29c | 7–7 |
| 66632 | ♀ | 123 | 27c | 7–7 | 66680 | ♂ | 122 | 32c | 7–7 |
| 66633 | ♀ | 125 | 26c | 7–7 | 66681 | ♂ | 120 | 31c | 7–7 |
| 66634 | ♀ | 122 | 26c | 7–7 | 66682 | ♀ | 125 | 28c | 8–7 |
| 66635 | ♀ | 125 | 26c | 7–7 | 66683 | ♂ | 116 | 34c | 7–7 |
| 66636 | ♂ | 117 | 34c | 7–7 | 66684 | ♂ | 122 | 33c | 7–7 |
| 66637 | ♀ | 128 | 27c | 6–6 | 66685 | ♀ | 123 | 24c | 7–7 |
| 66638 | ♂ | 122 | 14+ | 7–7 | 66686 | ♀ | 124 | 28c | 7–7 |
| 66639 | ♂ | 119 | 34c | 7–8 | 66687 | ♀ | 123 | 27c | 7–7 |
| 66640 | ♂ | 118 | 30c | 7–7 | 66688 | ♂ | 124 | 31c | 7–7 |
| 66641 | ♂ | 123 | 34c | 7–7 | 66689 | ♀ | 123 | 26c | 7–7 |
| 66642 | ♂ | 120 | 34c | 7–7 | 66690 | ♂ | 119 | 32c | 7–7 |
| 66643 | ♀ | 128 | 27c | 7–7 | 66691 | ♀ | 126 | 27c | 7–7 |
| 66644 | ♂ | 117 | 34c | 7–7 | 66692 | ♀ | 124 | 29c | 7–7 |
| 66645 | ♀ | 124 | 28c | 7–7 | 66693 | ♂ | 118 | 34c | 7–7 |
| 66646 | ♂ | 118 | 35c | 7–6 | 66694 | ♀ | 128 | 29c | 7–7 |
| 66647 | ♀ | 124 | 27c | 7–7 | 66695 | ♂ | 122 | 31+ | 7–7 |
| 66648 | ♀ | 126 | 28c | 7–7 | 66696 | ♀ | 123 | 24c | 7–7 |
| 66649 | ♂ | 119 | 33c | 7–7 | 66697 | ♂ | 124 | 34c | 7–7 |
| 66650 | juv. | 118 | 28c | 7–7 | 66698 | ♂ | 122 | 35c | 7–7 |
| 66651 | ♂ | 119 | 28+ | 7–7 | 66699 | ♂ | 118 | 32c | 7–7 |
| 66652 | ♀ | 123 | 27c | 7–7 | 66700 | ♀ | 125 | 26c | 8–7 |
| 66653 | ♂ | 119 | 31c | 7–7 | 66701 | ♂ | 118 | 34c | 7–7 |
| 66654 | juv. | 125 | 25c | 8–7 | 66702 | ♂ | 119 | 32c | 7–7 |
| 66655 | ♂ | 122 | 30c | 7–7 | 66703 | ♂ | 118 | 28c | 7–7 |
| 66656 | ♂ | 123 | 33c | 6–6 | 66704 | ♂ | 119 | 32c | 7–7 |
| 66657 | ♀ | 122 | 26c | 7–7 | 66705 | ♂ | 125 | 35c | 7–7 |
| 66658 | ♀ | 124 | 27c | 7–7 | 66706 | ♂ | 122 | 36c | 7–7 |
| 66659 | ♀ | 124 | 27c | 7–7 | 66707 | ♀ | 126 | 28c | 7–7 |
| 66660 | ♀ | 123 | 24c | 8–8 | 66708 | ♂ | 119 | 33c | 7–7 |
| 66661 | ♀ | 122 | 28c | 7–7 | 66709 | ♀ | 126 | 29c | 7–7 |
| 66662 | ♂ | 122 | 35c | 7–7 | 66710 | ♂ | 126 | 25c | 7–7 |
| 66663 | ♂ | 118 | 37c | 7–7 | 66711 | ♂ | 118 | 33c | 7–7 |
| 66664 | ♀ | 121 | 27c | 8–8 | 66712 | ♀ | 122 | 25c | 7–7 |
| 66665 | ♀ | 124 | 26c | 7–7 | 66713 | ♂ | 118 | 32c | 6–6 |
| 66666 | ♀ | 119 | 25c | 8–8 | 66714 | ♀ | 123 | 25+ | 7–7 |
| 66667 | ♀ | 122 | 27c | 7–7 | 66715 | ♂ | 123 | 31c | 6–6 |
| 66668 | ♂ | x | 31c | x–x | 66716 | ♂ | 122 | 33c | 7–7 |
| 66669 | ♂ | 119 | 34c | 7–7 | 66717 | ♂ | 119 | 32c | 7–7 |
| 66670 | ♀ | 124 | 29c | 7–7 | 66718 | ♀ | 122 | 25c | 7–7 |
| 66671 | ♂ | 118 | 32c | 6–6 | 66719 | ♂ | 125 | 31c | 7–7 |
| 66672 | ♂ | 124 | x | 7–7 | 66720 | ♀ | 119 | 25c | 7–7 |
| 66673 | ♀ | 124 | 24c | 7–7 | 66721 | ♂ | 120 | 33c | 7–7 |
| 66674 | ♂ | 121 | 30c | 7–7 | 66722 | ♀ | 123 | 18+ | 7–7 |
| 66675 | ♂ | 116 | 34c | 7–8 | 66723 | ♂ | 125 | 31+ | 7–7 |
| 66676 | ♀ | 125 | 26c | 7–7 | 66724 | ♀ | 121 | 25c | 7–7 |
| 66677 | ♂ | 121 | 32c | 7–7 | | | | | |

### **Catostoma rhodogaster** (Cope)

This species was found only in the highland country, where six specimens, Nos. 67010–67015, were taken in the vicinity of Chichivac. They were all found under debris at the site of an old sawmill.

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Post-oculars* | *Loreal* | *Tem-porals* |
|---|---|---|---|---|---|---|---|---|---|---|
| 67010 | ♂ | 17 | 140 | 45c | 1 | 6–6 | 7–7 | 1–1 | 1–1 | 1+2−1+2 |
| 67011 | ♂ | 17 | 139 | 45c | 1 | 6–6 | 6–6 | 1–1 | 1–1 | 1+2−1+2 |
| 67012 | ♂ | 17 | 135 | 44c | 1 | 6–6 | 7–6 | 1–1 | 1–1 | 1+2−1+2 |
| 67013 | ♂ | 17 | 138 | 44c | 1 | 6–6 | 7–6 | 1–1 | 1–1 | 1 −1+2 |
| 67014 | ♀ | 17 | 141 | 31c | 1 | 6–6 | 6–6 | 1–1 | 1–1 | 1+2−1+2 |
| 67015 | ♂ | 17 | 131 | 40c | 1 | 6–6 | 6–6 | 1–1 | 1–1 | 1+2−1+2 |

### **Tropidodipsas annulata** (Bocourt)

Twelve specimens were taken from under the bark of low cut stumps in the open areas about Chichivac. As will be seen by the scale counts three of these, Nos. 67042–67044, have one preocular, the loreal entering the eye in the remainder of the series. The black annuli range from 34–64 on the body, and from 12–22 on the tail. These are generally bordered by a single row of whitish colored scales. The dorsal region between the black annuli is a brownish-gray.

All have 17 scale rows, anal single, infralabials 7–7, postoculars 2–2, loreal 1–1, temporals 1+2−1+2.

Sexes and variation in scale counts are as follows:

| *Number* | *Sex* | *Gastro-steges* | *Uro-steges* | *Supra-labials* | *Number* | *Sex* | *Gastro-steges* | *Uro-steges* | *Supra-labials* | *Pre-oculars* |
|---|---|---|---|---|---|---|---|---|---|---|
| 67034 | ♂ | 180 | 57c | 6–6 | 67040 | ♂ | 179 | 57c | 7–6 | ...... |
| 67035 | ♂ | 176 | 60c | 7–7 | 67041 | ♂ | 179 | 67c | 6–6 | ...... |
| 67036 | ♀ | 190 | 40c | 7–7 | 67042 | ♂ | 176 | 47c | 7–7 | 1–1 |
| 67037 | ♀ | 188 | 57c | 6–6 | 67043 | ♂ | 175 | 53+ | 6–7 | 1–1 |
| 67038 | ♀ | 177 | 60c | 6–6 | 67044 | ♂ | 181 | 53c | 7–7 | 1–1 |
| 67039 | ♀ | 188 | 53c | 6–6 | 67045 | ♂ | 163 | 47c | 7–7 | ...... |

### **Imantodes cenchoa** (Linnaeus)

Six of these arboreal snakes, Nos. 69940–69945, were found at Finca El Cipres, Volcan Zunil, entwined about the limbs of the coffee trees, close in toward the trunk. It is probably not an uncommon species, but difficult to locate amongst the dense foliage. All have strongly enlarged vertebrals.

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Tem-porals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66940 | x | 17 | 242 | 137+ | ÷ | 8–8 | 10–9 | 1–1 | 2–2 | 1–1 | 2+3−2+3 |
| 66941 | x | 17 | x | 126c | ÷ | 8–8 | x–10 | 1–1 | 2–2 | 1–1 | 2+3−2+3 |
| 66942 | x | 17 | 220 | 126c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2−1+2 |
| 66943 | x | 17 | 224 | 114c | ÷ | 8–8 | 10–11 | 2–2 | 2–2 | 1–1 | 1+3−1+3 |
| 66944 | ♂ | 17 | 252 | 147c | ÷ | 9–9 | 10–10 | 1–1 | 3–3 | 1–1 | 2+3−2+3 |
| 66945 | ♀ | 17 | 242 | 142c | ÷ | 8–8 | 10–11 | 1–1 | 3–3 | 1–1 | 2+3−2+3 |

### **Leptodeira annulata polysticta** (Gunther)

Two specimens, Nos. 66937–66938, are from Finca El Cipres, Volcan Zunil. Both show a short longitudinal line on the neck. Both were found in similiar situations as *Imantodes cenchoa.*

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Tem-porals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66937 | x | 23 | 199 | 82c | ÷ | 8–8 | 10–10 | 2–2 | 2–2 | 1–1 | 1+2−1+2 |
| 66938 | ♀ | 23 | 203 | 84+ | ÷ | 8–8 | 10–10 | 2–2 | 2–2 | 1–1 | 1+2−1+2 |

### **Pseudoboa clœlia** (Daudin)

Three specimens were dug out of piles of debris in the cafetals at Finca El Cipres, Volcan Zunil. In life this oddly marked snake has a ground color of dark pink, with a large bluish spot occupying the center of each scale. In alcoholic specimens the ground color may become a light reddish-brown, with the blue spots turning a darker brown. The head is blackish, with a large yellowish band crossing the parietals and extending down on to the neck. The undersurfaces are uniform yellowish, with the gular region somewhat clouded.

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Tem-porals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66917 | ♀ | 17 | 208 | 88c | 1 | 7–7 | 8–8 | 1–1 | 2–2 | 1–1 | 2+3−2+3 |
| 66918 | ♀ | 17 | 221 | 81c | 1 | 7–7 | 8–8 | 1–1 | 2–2 | 1–1 | 2+3−2+3 |
| 66919 | ♂ | 17 | 210 | 89c | 1 | 7–7 | 8–8 | 1–1 | 2–2 | 1–1 | 2+3−2+3 |

### **Conophis lineatus** (Duméril and Bibron)

Two specimens, both showing the typical striping, were taken, one No. 66999 was captured as it emerged from a hole in the ground, close to the road entering the town of San Antonio, and the other, No. 67000, under a stone at Progreso, a range in elevation of about 2,500 feet.

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Tem-porals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 66999 | ♂ | 19 | 166 | 69c | ÷ | 8–8 | 9–9 | 1–1 | 3–3 | 1–1 | 2–2 |
| 67000 | ♂ | 19 | 166 | 58c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 2–2 |

### **Oxybelis acuminatus** (Wied)

A single example of this species given to me by my host Señor Posadas has scales in 17 rows, urosteges 166c, anal divided, supralabials 9–9, infralabials 9–9, preoculars 1–1, postoculars 2–2, temporals 1+2−1+2. I did not meet with the species myself, but the Indians report it as not rare.

## **Coniophanes punctigularis** Cope

A common species at Finca El Cipres, Volcan Zunil, where 87 specimens, Nos. 66421–66507, were dug from piles of earth in the cafetals. There appears to be little if any variation in color throughout the series. All have 21 scale rows, anal divided, supralabials 8–8, with the exception of No. 66497, which has seven on the left side, preoculars 1–1, postoculars 2–2, loreal 1–1. The temporals are 1+2, with the exception of No. 66475, which has 1+1 on the right side.

Sexes and variation in scale counts are as follows:

| *Number* | *Sex* | *Gastro-steges* | *Uro-steges* | *Infra-labials* | *Number* | *Sex* | *Gastro-steges* | *Uro-steges* | *Infra-labials* |
|---|---|---|---|---|---|---|---|---|---|
| 66421 | ♀ | 126 | 74c | 10–10 | 66457 | ♀ | 126 | 42+ | 10–10 |
| 66422 | x | 125 | 7+ | 9–9 | 66458 | ♂ | 124 | 80+ | 9–9 |
| 66423 | ♂ | 123 | 81c | 9–9 | 66459 | ♂ | 119 | 15+ | 10–10 |
| 66424 | ♂ | 117 | 81c | 10–10 | 66460 | ♀ | 126 | 74c | 10–10 |
| 66425 | ♂ | 121 | 82c | 9–9 | 66461 | ♀ | 124 | 80c | 10–10 |
| 66426 | ♂ | 120 | 78c | 9–9 | 66462 | ♂ | 119 | 12+ | 10–10 |
| 66427 | juv. | 121 | 78c | 9–9 | 66463 | ♀ | 128 | 79c | 10–10 |
| 66428 | juv. | 124 | 72c | 9–9 | 66464 | ♀ | 126 | 81c | 10–10 |
| 66429 | ♀ | 125 | 74+ | 10–10 | 66465 | ♀ | 125 | 75c | 9–9 |
| 66430 | ♀ | 125 | 70c | 10–10 | 66466 | ♂ | 116 | 83c | 9–9 |
| 66431 | ♂ | 122 | 37+ | 10–10 | 66467 | ♀ | 123 | 56+ | 10–10 |
| 66432 | juv. | 121 | 71+ | 10–10 | 66468 | ♂ | 121 | 81c | 9–9 |
| 66433 | ♀ | 124 | 21+ | 10–10 | 66469 | ♀ | 127 | 73c | 9–9 |
| 66434 | ♀ | 126 | 76c | 10–10 | 66470 | ♂ | 119 | 84c | 9–9 |
| 66435 | juv. | 120 | 80c | 9–9 | 66471 | ♂ | 120 | 77c | 10–10 |
| 66436 | juv. | 118 | 40+ | 10–10 | 66472 | ♀ | 127 | 74+ | 10–10 |
| 66437 | ♂ | 120 | 79c | 9–9 | 66473 | ♂ | 120 | 77c | 9–9 |
| 66438 | ♂ | 120 | 23+ | 9–9 | 66474 | ♂ | 121 | 82c | 9–9 |
| 66439 | juv. | 122 | 70c | 9–9 | 66475 | ♀ | 122 | 34+ | 9–10 |
| 66440 | ♀ | 125 | 51+ | 10–10 | 66476 | ♀ | 125 | 76+ | 10–10 |
| 66441 | ♂ | 121 | 17+ | 10–10 | 66477 | ♂ | 120 | 45+ | 10–10 |
| 66442 | ♂ | 122 | 66+ | 9–9 | 66478 | ♂ | 118 | 48+ | 9–10 |
| 66443 | ♂ | 117 | 82c | 10–10 | 66479 | ♀ | 125 | 48+ | 10–10 |
| 66444 | ♂ | 118 | 57+ | 10–10 | 66480 | ♀ | 124 | 78c | 9–9 |
| 66445 | ♀ | 122 | 41+ | 10–10 | 66481 | ♀ | 125 | 76c | 9–9 |
| 66446 | ♀ | 128 | 74c | 10–10 | 66482 | ♀ | 126 | 20+ | 9–9 |
| 66447 | ♂ | 119 | 78c | 10–10 | 66483 | ♀ | 128 | 77c | 10–10 |
| 66448 | ♀ | 114 | 70c | 9–9 | 66484 | ♂ | 119 | 81c | 10–10 |
| 66449 | ♂ | 120 | 83c | 10–9 | 66485 | ♂ | 116 | 69+ | 9–9 |
| 66450 | ♂ | 121 | 41+ | 10–10 | 66486 | ♂ | 120 | 79c | 10–9 |
| 66451 | ♂ | 118 | 86c | 10–10 | 66487 | ♀ | 126 | 76c | 9–9 |
| 66452 | ♂ | 122 | 67+ | 10–10 | 66488 | ♂ | 120 | 63+ | 9–9 |
| 66453 | ♂ | 119 | 77c | 10–10 | 66489 | ♀ | 116 | 73+ | 10–10 |
| 66454 | ♀ | 123 | 71c | 9–9 | 66490 | ♀ | 130 | 77c | 9–9 |
| 66455 | ♂ | 121 | 14+ | 10–10 | 66491 | ♂ | 116 | 69+ | 10–10 |
| 66456 | ♂ | 119 | 67c | 10–10 | 66492 | ♀ | 130 | 51+ | 10–10 |

| Number | Sex | Gastro-steges | Uro-steges | Infra-labials | Number | Sex | Gastro-steges | Uro-steges | Infra-labials |
|---|---|---|---|---|---|---|---|---|---|
| 66493 | ♂ | 118 | 52+ | 9–9 | 66501 | ♀ | 130 | 6+ | 9–9 |
| 66494 | ♂ | 123 | 79c | 10–10 | 66502 | ♂ | 118 | 28+ | 9–9 |
| 66495 | ♂ | 122 | 80+ | 9–9 | 66503 | ♂ | 119 | 34+ | 10–9 |
| 66496 | juv. | 126 | 74c | 9–9 | 66504 | ♂ | 122 | 65+ | 9–10 |
| 66497 | ♀ | 128 | 76c | 9–9 | 66505 | ♀ | 130 | 72c | 9–9 |
| 66498 | ♂ | 121 | 74+ | 10–10 | 66506 | ♂ | 122 | 32+ | 9–9 |
| 66499 | ♂ | 123 | 53+ | 10–10 | 66507 | ♂ | 118 | 82c | 10–10 |
| 66500 | ♂ | 118 | 75+ | 10–10 | | | | | |

### **Tantilla fusca** (Bocourt)

A fairly common species at Finca El Cipres, Volcan Zunil, where 19 specimens, Nos. 66891–66909, were taken. All show a light lateral line and a yellowish-white collar. The head is blackish, with yellowish spotting on the side and the tip of the snout. All have 15 scale rows, anal divided, supralabials 7–7, infralabials 7–7, preoculars 1–1, postoculars 2–2, temporals 1+1 – 1+1.

Sexes and variations in scale counts are as follows:

| Number | Sex | Gastro-steges | Uro-steges | Number | Sex | Gastro-steges | Uro-steges |
|---|---|---|---|---|---|---|---|
| 66891 | ♂ | 140 | 50c | 66901 | ♂ | 146 | 46c |
| 66892 | ♂ | 143 | 35+ | 66902 | ♀ | 150 | 19+ |
| 66893 | juv. | 142 | 40c | 66903 | ♂ | 139 | 47c |
| 66894 | ♂ | 140 | 41+ | 66904 | ♀ | 149 | 40c |
| 66895 | ♂ | 151 | 49c | 66905 | ♂ | 139 | 45c |
| 66896 | ♀ | 153 | 42c | 66906 | ♀ | 153 | 42c |
| 66897 | ♂ | 144 | 49c | 66907 | ♂ | 146 | 47c |
| 66898 | ♀ | 151 | 37+ | 66908 | x | 154 | 5+ |
| 66899 | x | 151 | 18+ | 66909 | ♂ | 141 | 48c |
| 66900 | ♂ | 147 | 45c | | | | |

### **Stenorhina degenhardtii** (Berthold)

A single specimen, No. 67001, found under a stone at Progreso, has scales in 17 rows, gastrosteges 173, urosteges 33c, anal divided, supralabials 7–7, infralabials 7–7, preoculars 1–1, loreal 1–1, temporals 1+2 – 1+2.

This specimen is the reddish type of coloration, with three longitudinal black lines and the under parts uniform yellowish.

## **Micrurus nigrocinctus zunilensis** Schmidt

This new subspecies, distinguished by coloration and geographic range, was described by Mr. Karl Schmidt[3]. Thirteen specimens, No. 66001 (the type), Nos. 66949–66954 and Nos. 66956–66961, were dug from piles of earth in the cafetals of Finca El Cipres, Volcan Zunil.

All have scales in 15 rows, anal divided, supralabials 7–7, infralabials 7–7, preoculars 1–1, postoculars 2–2, temporals $1+1-1+1$, with the exception of the type, which has $1+2$ on the left side.

Sexes and variations in scale counts are as follows:

| *Number* | *Sex* | *Gastro-steges* | *Uro-steges* | *Number* | *Sex* | *Gastro-steges* | *Uro-steges* |
|---|---|---|---|---|---|---|---|
| 66001 | ♂ | 198 | 46c | 66956 | ♂ | 198 | 52c |
| 66949 | ♀ | 215 | 35c | 66957 | ♂ | 193 | 45c |
| 66950 | ♀ | 208 | 38c | 66958 | ♀ | 210 | 38c |
| 66951 | ♀ | 195 | 48c | 66959 | ♀ | 216 | 33c |
| 66952 | ♂ | 203 | 48c | 66960 | ♂ | 202 | 50c |
| 66953 | ♂ | 197 | 52c | 66961 | ♂ | 205 | 49c |
| 66954 | ♂ | 202 | 50c | | | | |

## **Bothrops godmani** (Gunther)

This species was found only in the highlands in the vicinity of Chichivac, where eight specimens, Nos. 67026–67033 were taken under the bark of fallen logs. Strange to say they were all found on the top of the log when the bark was removed, and not wedged in on the sides, as is often the case with snakes in general.

Scale counts are as follows:

| *Number* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* |
|---|---|---|---|---|---|---|---|---|---|---|
| 67026 | ♂ | 21 | 140 | 30c | 1 | 8–9 | 11–10 | 2–2 | 3–3 | 1–1 |
| 67027 | ♂ | 21 | 137 | 27c | 1 | 9–9 | 11–11 | 2–2 | 3–3 | 1–1 |
| 67028 | ♂ | 21 | 139 | 28c | 1 | 10–10 | 11–11 | 2–2 | 4–4 | 1–1 |
| 67029 | ♀ | 19 | 131 | 27c | 1 | 9–9 | 10–11 | 2–2 | 3–4 | 1–1 |
| 67030 | ♀ | 21 | 138 | 26c | 1 | 9–9 | 10–11 | 2–2 | 3–4 | 1–1 |
| 67031 | ♂ | 21 | 133 | 24c | 1 | 10–9 | 11–11 | 2–2 | 3–3 | 1–1 |
| 67032 | ♀ | 21 | 140 | 24c | 1 | 9–10 | 10–10 | 2–2 | 3–3 | 1–1 |
| 67033 | ♀ | 23 | 138 | 27c | 1 | 10–10 | 12–11 | 2–2 | 3–3 | 1–1 |

[3] Proc. Calif. Acad. Sci., Ser. 4, Vol. XX, No. 7, pp. 265–267.

### **Bothrops nigroviridis aurifera** (Salvin)

A single specimen (♀), No. 67049, was given to me by Señor Axel Pira, my host at Chichivac, who captured it in Quiche Province at Finca El Soche, about 25 miles west of Coban.

It has scales in 19 rows, gastrosteges 162, urosteges 58c, anal single, supralabials 9–9, infralabials 10–11, preoculars 2–2, postoculars 3–3, loreal 1–1.

### **Crotalus terrificus durissus** (Cope)

One specimen, a female, No. 67048, taken in the arid country south of Progreso, has 29 scale rows, gastrosteges 185, urosteges 23c, anal single, preoculars 2–2, postoculars 2–2, loreal 2–2.

This was the only specimen seen during twelve days intensive hunting in excellent-looking rattlesnake country. The natives reported them to be very scarce in the vicinity.

## Plate 37

Fig. 1. The small pile of earth seen in the lower right hand corner of the picture is the type of cover in which ten species of snakes were found:

| | |
|---|---|
| *Ninia sebæ* | *Catostoma chalybeum* |
| *Xenodon colubrinus* | *Pseudoboa cloelia* |
| *Urotheca e. elapoides* | *Coniophanes punctigularis* |
| *Trimetopon posadasi* | *Tantilla fusca* |
| *Adelphicos quadrivirgatus* | *Micrurus nigrocinctis zunilensis* |

Fig. 2. A road at Finca El Cipres, the type of country inhabited by *Drymarchon corais melanurus* and *Sybinophis annulatus.*

## Plate 38

Fig. 1. A road at Progreso. The vegetation in this arid country resembles that of the deserts in the western United States.

Fig. 2. A trail through the forest above Chichivac. On the lower edge of this forest is the home of *Bothrops godmani.*

Fig. 2

Fig. 1

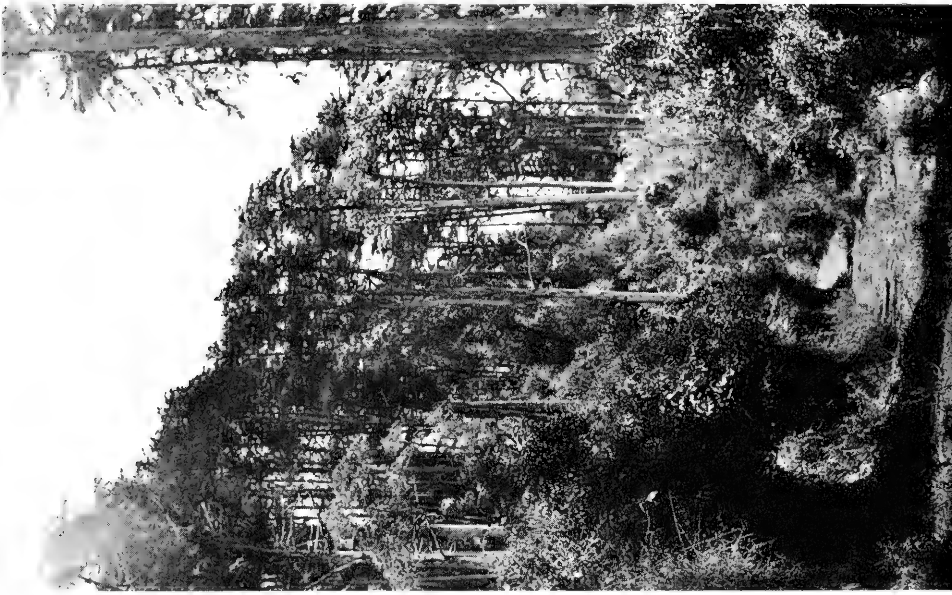

Fig. 2

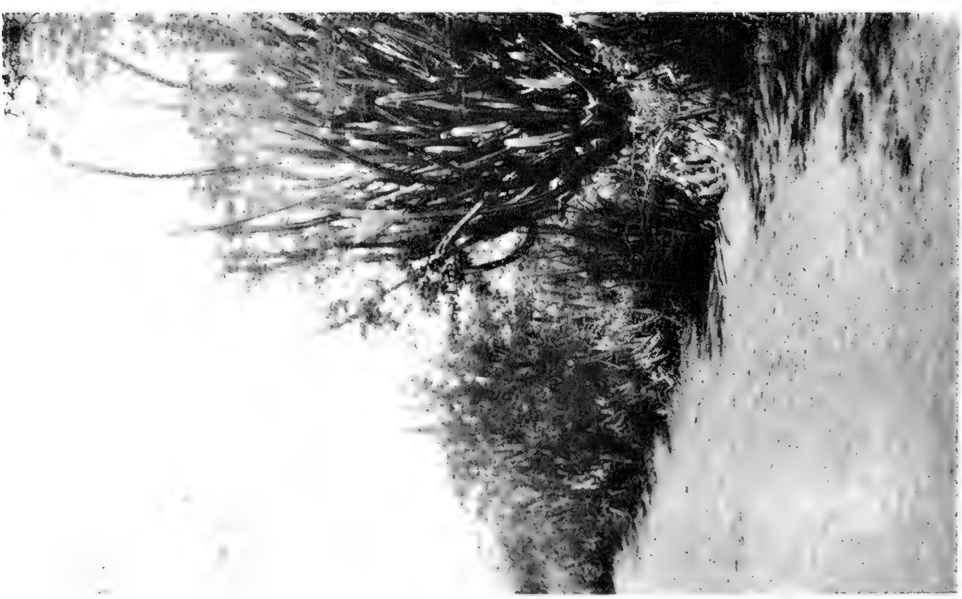

Fig. 1

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No. 27

# A NEW GENUS AND SPECIES OF MARINE OSTRACODS FROM SOUTH GEORGIA*

BY

TAGE SKOGSBERG

*Hopkins Marine Station,*
*Pacific Grove, California*

The somewhat extensive material of marine Ostracods brought home by the Swedish Antarctic Expedition, 1900-1901, contained a rather large number of species new to science. The material, which was entrusted to me, has been examined, but circumstances have not allowed me to publish all the results. Indeed, following the publication of Skogsberg, 1920 and 1928,[1] in which the species belonging to *Myodocopa* and *Cladocopa* and to the genus *Cythereis* of *Podocopa* were presented, the description of the bulk of the material still remained unpublished. The following new species belonging to a new genus was found in this material.

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* Printed from the John W. Hendrie Publication Endowment.

[1] Skogsberg, T. Studies on Marine Ostracods. I. Cypridinids, Halocyprids, and Polycopids. Uppsala, 1920.

Skogsberg, T. Studies on Marine Ostracods. II. External Morphology of the Genus Cythereis with Descriptions of twenty-one New Species. Occ. Pap. Calif. Acad. Sci. XV, San Francisco, 1928.

December 29, 1939

## **Copytus** Skogsberg, new genus

*Diagnosis:*

Shell: Without noticeable sex dimorphism. Elongated, low, with smooth surface. Left valve somewhat larger than the right, the edge of which it partly overlaps. Inner line and line of junction widely separated along anterior and posterior margins of shell and coincide along middle portion of ventral margin. Marginal pores simple, moderate in number. Selvage narrow, hard to detect, apparently with smooth edge. Eye probably absent (if present, very small). Hinge without teeth. Four muscle impressions form a small, rounded group near middle of each valve, and a small, single impression occurs somewhat in front of this group. Calcareous, but thin and fragile.

First antenna: No sex dimorphism. Of moderate length and strength; 5-jointed; fourth joint composed of 2 merged joints, with slight traces of original division; when at rest, with the 3 distal joints bent upwards, the third joint forming a rather decided knee with the second. First joint without bristles. Second joint with a long bristle at about middle of posterior side. The 3 distal joints with same number of bristles as in subgenus Cythereis (Jones); some of these bristles rather long, some rather strong; 1 of the 4 distal bristles of end joint narrow, subequal in width throughout, rounded distally, hyaline, sensory, and joined to its neighbor at base.

Second antenna: No sex dimorphism. Of moderate strength but rather short, due to shortness of second endopodite joint. Exopodite long, 2-jointed. First endopodite joint with 1 postero-distal bristle. Second endopodite joint with 2 bristles on anterior side, 3 at about middle of posterior (1 of these sensory), and 1 postero-distally. Third endopodite joint with 4 bristles, 1 of which is rather weak and short, the others claw-like and fairly long.

Mandible: No sex dimorphism. First (protopodite) joint of moderate size and strength, narrow, wedge-shaped; its proximal part without rounded hump on anterior side; its part below palp (pars incisiva) about 3 times longer than toothed edge and with distinct posterior notch; toothed edge with about 6 teeth, of which the anterior is simple and rather large; the remaining ones decrease in size posteriorly, the posterior one being very small; 2 short bristles between teeth number 1 and 2; and a similar bristle between teeth number 2 and 3; at base of small posterior tooth, there are 2 short bristles. On anterior side of this joint, somewhat ventrally to palp, there is 1 rather short bristle with short hairs. Palp about as long as first protopodite joint, with thin walls, 3-jointed (second protopodite and first endopodite joints almost completely merged). Second protopodite joint with 2 ventral bristles (as in sub-genus Cythereis). Epipodial appendage with 1 bristle and a scale-like process (the latter directed forward in Fig. 5); its position relative to second protopodite joint can not be established due to merging of joints, but probably the same as in sub-genus *Cythereis*. First endopodite joint (just as second protopodite joint) shorter than high; with 2 dorso-distal bristles, and with 3 bristles located somewhat more ventrally; one of the more ventral ones is of extraordinary size, non-annulated, and furnished along its entire length with numerous, long, stiff hairs, arranged as the pinnules of a feather. Second endopodite joint very long and narrow (6-7 times as long as high), and of subuniform width throughout; with but a few (about 4) weak bristles distally. End joint of about the same shape and with the same number (4) of bristles as in sub-genus *Cythereis*.

Maxilla: No distinct sex dimorphism. Epipodial appendage of about the same size as in the genus *Cytheretta* (G. W. Müller, 1894; pl. 39, fig. 10); with about 17–18 marginal bristles. The anterior two of these bristles directed forward and located on a small, lobe-like process; the remaining ones of about the same type and relative lengths as in figure mentioned above. Protopodite with 3 well developed endites; the two distal usually about twice as long as high or slightly longer, and a little shorter than first joint of palp; the proximal endite generally slightly shorter and higher than the distal ones. Each endite with 6–7 bristles. Palp distinctly 2-jointed; first joint rather large; end joint small. These joints with about 3 and 4 bristles, respectively.

Fifth limb: Without, or with hardly distinguishable, sex dimorphism. Of moderate strength and length, somewhat smaller and weaker than in the sub-genus Cythereis; 4-jointed. Protopodite with 4 bristles on anterior side: 2 distally and 2 near or somewhat proximally to middle; of the latter 2, the one is situated somewhat proximally to the other. Epipodial appendage situated somewhat proximally to middle of posterior side of this joint, and consists of a small lobe with 2 long bristles, both non-annulated, soft, and furnished with moderately long, soft hairs. Exopodite with 2 bristles, viz., 1 ventro-distally on first joint, the other forming the end claw.

Sixth limb: Without sex dimorphism, or nearly so. Differs from generic type of fifth limb mainly in having a slightly longer exopodite and in having only 1 bristle antero-distally on protopodite.

Seventh limb: Without sex dimorphism, or nearly so. Differs from generic type of sixth limb chiefly by having a somewhat longer exopodite, by having only 1 bristle at about middle of anterior side of protopodite, and by having the epipodite represented by a single bristle.

Brush-shaped organ: Of ordinary type, about as in the genus Cytheretta, as figured by G. W. Müller (1894, pl. 39, fig. 19).

Penis: See description of species, below.

Furca: In the female: Relatively large, but short; with about 5 bristles. Same number of bristles found in male, in which furca is attached to penis.

**Copytus caligula** Skogsberg, new species

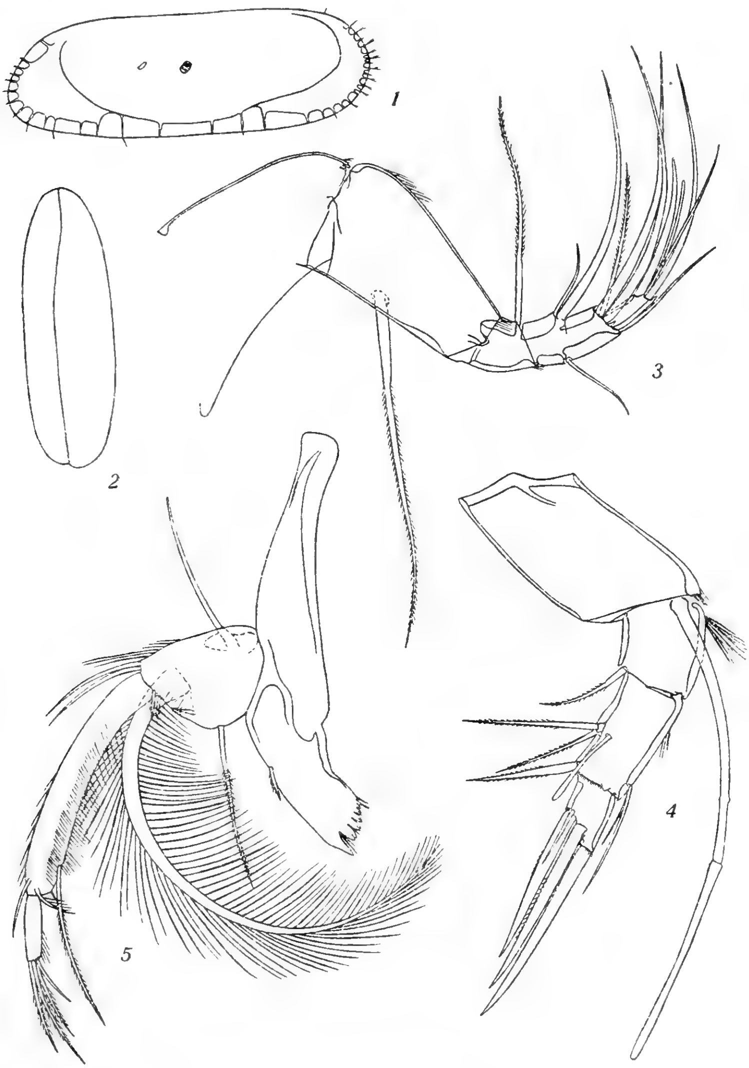
*Description: Male:*

Shell (Figs. 1, 2): Length, 0.94–1.02 mm. Length : height, about 3:1. Length : breadth, 3.20–3.25:1. Seen from the side, oblong, subequal in height nearly throughout; extremities rounded, the posterior subcircular, the anterior somewhat depressed dorsally. Seen from below, narrowly subobovoidal, broadest at about the middle, broadly pointed anteriorly, asymmetrically rounded posteriorly; with even contours. Pores of surface almost impossible to detect, small and few; some of them with very short bristles. Marginal pores of about the types shown in Fig. 1; some of those along anterior margin of shell with short, fine, simple bristles; most of those along posterior margin with short, or moderately long, fine bristles, some of which are bifurcated. When shell is regarded in transmitted light, no dark fields can be detected.

First antenna (Fig. 3): The 2 proximal joints with rather thin walls; third and fourth joints with thick walls. First and second joints taper quite strikingly distally. Relative lengths of joints about as follows:

$$\text{I} \quad \frac{10}{12} \quad \text{II} \quad \frac{13}{10} \quad \text{III} \quad \frac{2.5}{4} \quad \text{IV} \quad \frac{5}{6} \quad \text{V} \quad \frac{3}{3}$$

Fourth joint shows on medial side traces of a division into 2 subequal joints. Bristle at about middle of posterior side of second joint about as long as posterior side of the 4 distal joints; of moderate strength; with short, fine hairs; and non-annulated, or nearly so. Bristle of third joint antero-distal; of about same type as bristle of second joint but smaller, about as long as or somewhat shorter than anterior side of second joint. Of the 7 bristles of fourth joint, 3 are situated near middle of joint. Two of these 3 bristles are on anterior side, 1 on posterior side of joint; the posterior and 1 of the anterior are rather weak, non-annulated, naked or almost so, and about as long as or slightly longer or shorter than this joint; remaining one of these 3 is non-annulated, naked, rather strong, gradually tapering to a very fine point, and about as long as or somewhat longer or shorter than posterior sides of second and third joints. The 4 remaining bristles of the fourth joint situated distally; 2 of them are antero-medial, and of same type and length as long bristle just described; of the other 2, 1 is posterior, rather weak, non-annulated, naked or almost so, and about as long as distal joint or somewhat longer; and 1 is antero-lateral, of about the same type as the last mentioned bristle but somewhat longer and furnished with short, fine hairs. Of the 4 bristles of the distal joint, 1 is of about same type and length as the small antero-distal bristle of the preceding joint but naked or almost so; 1 is anterior, about 3 times longer than end joint, non-annulated, naked or almost so, gently curved, and rather strong. The claviform, narrow, sensory bristle is somewhat shorter than the last-mentioned bristle and about half as long as its neighbor, to which it is attached at the base. The last bristle is of about the same type as, but slightly shorter and distinctly




*Copytus caligula* Skogsberg, new species.

Fig. 1. Left valve, lateral view. × 50. 2. Shell, ventral view, anterior end up. × 39. 3. Left first antenna, from inside. × 270. 4. Right second antenna, from outside. × 270. 5. Right mandible, from inside. Type specimen, male. South Georgia, off mouth of Cumberland Bay.

weaker than the long and strong bristle at about middle of anterior side of fourth joint. Medio-distally on fourth joint, there is a minute spine. Pilosity: A few hairs are to be found dorso-distally on first joint; anteriorly, near proximal boundary, and antero-distally on second joint; and postero-distally on third joint.

Second antenna (Fig. 4): Walls of joints moderately thick. Relative lengths of joints about as follows:

$$\text{Protopodite}\ \frac{11}{11}\quad \text{Endopodite}\ \ \text{I}\ \frac{5}{3.5}\quad \text{II}\ \frac{7}{6.5}\quad \text{III}\ \frac{3.5}{3.5}$$

Exopodite rather narrow; its proximal joint shows possible signs of division in 2 joints, and is about as long as anterior side of endopodite; its distal joint about as long as total length of first and second endopodite joints. Postero-distal bristle of first endopodite joint about as long as or slightly shorter than second endopodite joint, of moderate strength, and furnished with short hairs. The 2 bristles on anterior side of second endopodite joint are closely-set, near distal boundary of joint, narrow, non-annulated, and naked; 1 about as long as or slightly longer or shorter than anterior side of distal joint; 1 usually not quite twice as long as its neighbor. Of the 3 bristles at about middle of this joint, 2 are of about same type as bristle of first endopodite joint, the lateral being about as long as second endopodite joint, the medial usually somewhat shorter. The sensory bristle is situated laterally and usually somewhat in front of the other 2 bristles; its tip reaches to base of proximal claw of end joint, or nearly so. Postero-distal bristle of second endopodite joint of about same type as postero-lateral of 3 last-mentioned bristles, but somewhat stronger and about as long as or slightly shorter than this bristle. The 3 claws of distal joint are all of about same type; rather strong, well-pointed, almost straight, and naked or furnished with only a very weak pectination; the distal (anterior) of them about as long as or slightly shorter than anterior sides of first and second endopodite joints; the middle one of subequal length; the posterior somewhat shorter. The short and weak end-bristle is situated laterally to posterior end-claw, naked, non-annulated, or nearly so, and less than half as long as its neighbor. Pilosity: Dorso-distally on protopodite, a group of short hairs. Near proximal boundary of first endopodite joint, on anterior side, there is a bunch of rather long hairs. A group of rather short hairs is also found somewhat proximally to middle of anterior side of second endopodite joint. This joint has also a fine pectination distally, both on medial and lateral sides. Fine pectination is also found at base of distal end claw.

Mandible (Fig. 5): Pars incisiva with 6 teeth, number 2–6 of which are bifurcate, their 2 points being subequal in size. Bristle on anterior side of this part usually somewhat shorter than toothed edge. Of the 2 bristles of second protopodite joint, the proximal is non-annulated or nearly so, with short hairs, of moderate strength, and its point reaches almost to the toothed edge of pars incisiva; the distal of these 2 bristles is nearly vestigial, furnished with rather short hairs. Epipodial bristle about as long as pars incisiva; no hairs on it were detected. The 2 dorso-distal bristles of first endopodite joint rather weak, non-annulated, naked or nearly so, subequal, and about half as long as second endopodite joint, or slightly shorter. The 2 medio-distal bristles of this joint about as long as their neighbor is thick at base, with hairs of moderate length. The length of their neighboring bristle usually exceeds length of dorsal side of palp. Second endopodite joint about twice longer than dorsal side of first palp joint (second protopodite and first endopodite joints), or even somewhat longer, and about 6 times longer than high, or even slightly more elongated. There are 4 bristles near distal border of this joint; 1 of these, situated ventrally, and somewhat proximally to the others, is rather weak, non-annulated, with short hairs, and is about half as long as this joint or somewhat longer; 2 are about as long as distal joint, or somewhat shorter, non-annulated, and weak, 1 of them being naked, or nearly so, the other furnished with a few rather long hairs. The remaining bristle of this joint is nearly vestigial. The 4 bristles of distal joint rather weak, non-annulated, with short hairs or almost naked; the longest of them about as long as this joint or somewhat longer; the shortest somewhat shorter than the joint. Pilosity: First endopodite joint with group of long hairs dorsally; ventrally it has a few rather short hairs. Second endopodite joint has 4 longitudinal rows of rather short hairs, one dorsally, one ventrally, and one on either side. Distal joint with a few hairs ventro-distally.

Maxilla (Figs. 6, 7): Epipodial appendage consists of 2 lobes, of which the anterior is subequal in size to masticatory part of this limb. Of the 2 bristles of the anterior lobe, the anterior one is rather long and furnished with long, fine hairs, such as those of the bristles of the posterior, main, lobe of the appendage. The remaining bristle is naked or almost so, about one-third to one-fourth the length of the anterior bristle, and of the peculiar shape shown in Fig. 6. First endite with 6 distal bristles, of which the posterior is rather strong and about as long as or somewhat longer than dorsal side of first joint of palp, non-annulated, and naked or nearly so; the remaining ones rather weak and about one-third the length of posterior bristle, non-annulated or almost so, most of them furnished with a few, moderately long, stiff hairs. Second endite has 7 distal bristles of about same types and sizes as the 5 shorter bristles of first endite. Third endite also with 7 bristles, resembling those of preceding endite but on the average very slightly longer and stronger and with fewer hairs. First joint of palp about half as high as this limb is at base of endites and usually not much longer than high. Dorso-distally it has 2 bristles, both apparently rather soft, 1 about twice as long as dorsal side of joint or somewhat longer or shorter and furnished with rather long, soft hairs, and 1 which is about half as long or slightly more and usually naked or almost so. Somewhat ventrally and proximally to these 2 bristles, there is a single soft bristle, usually about half as long as dorsal side of joint and furnished with rather long hairs. Distal joint more or less rounded, with 4 bristles; dorsal one of these about as long as dorsal side of preceding joint, with rather long hairs; next bristle of same type but about half as


*Copytus caligula* Skogsberg, new species.

Fig. 6. Maxilla. × 175. 7. Palp and endites of maxilla. × 435. 8. Fifth limb. × 270. 9. Sixth limb. × 270. 10. Seventh limb. × 270. 11. Hind portion of body, seen from left side. × 225. 12. Chitinous skeleton of side of body, above fifth to seventh limbs; from left side. × 410. Figs. 6–10, from type specimen, male; figs. 11 and 12, from female.

long; 2 remaining ones short, the dorsal one being about as long as joint, the other slightly shorter, both of them naked or almost so. The entire limb appears to be without pilosity.

Fifth limb (Fig. 8): Protopodite relatively broad; first exopodite joint about as long as or but slightly shorter than total length of the 2 distal joints which are subequal. Walls of joints rather thin. Distal one of 2 bristles near middle of anterior side of protopodite and medial knee bristle about as long as or somewhat shorter than first exopodite joint, soft, and furnished with long, soft hairs. Proximal bristle on anterior side of this joint about as long as this side or slightly shorter, furnished with short hairs. Lateral bristle at knee is claw-like, naked or almost so, and about as long as or somewhat shorter than distal width of protopodite. All protopodite bristles non-annulated. Of the 2 bristles of epipodite, the ventral is somewhat longer than its neighbor, and about as long as or somewhat longer than first exopodite joint. Bristle of first exopodite joint usually somewhat longer than second exopodite joint, of moderate strength, non-annulated, and with short hairs. Distal claw rather weak, about as long as total length of 2 distal joints, gently curved, and with weak pectination. Two distal joints ventro-distally with a few short, fine hairs.

Sixth limb (Fig. 9): Protopodite somewhat narrower than in preceding limb. Of the 2 bristles at about middle of anterior side of protopodite, the proximal usually is about same size and type as corresponding bristle of preceding limb; however, it may be as short as in Fig. 9. The distal of these 2 bristles agrees with corresponding bristle of fifth limb, but is about as long as total length of first 2 exopodite joints, or slightly more or less. Bristle at knee has about same type and length as lateral knee bristle of fifth limb, but it is slightly smaller. Epipodite of about same type as that of fifth limb, but its lobe is usually somewhat smaller. Bristle of first exopodite joint differs from that of fifth limb by being slightly longer. The same is true in regard to the end claw. Pilosity agrees with that of fifth limb.

Seventh limb (Fig. 10): Proximal part of protopodite somewhat broader than in sixth limb. First exopodite joint somewhat longer than total length of 2 distal joints which either are subequal or the distal one is slightly the shorter. Bristle at about middle of anterior side of protopodite resembles the longer bristle at this place of sixth limb, and is sometimes even somewhat longer than total length of first 2 exopodite joints. Bristle at knee may be weaker than corresponding one of sixth limb; with short, fine hairs. Epipodial bristle thin, usually somewhat longer than distal joint and furnished with short hairs. Bristle of first exopodite joint about as long as total length of 2 distal joints, with fine short hairs. End claw with fine pectination; slightly longer than total length of 2 distal joints. Pilosity about as on preceding limb, or second exopodite joint is naked.

Chitinous skeleton of last 3 limbs, at sides of body, is quite weak. As shown by Fig. 12, it is represented by a strip from postero-dorsal corner of each of these appendages, and by a few, narrow strips from dorsal ends of these strips.

*Copytus caligula* Skogsberg, new species.

Fig. 13. Penis. × 260.

Penis (Fig. 13): Both organs of same type and quite constantly as figured. Body of penis rounded dorsally, with small, triangular process anteriorly, near copulatory appendage. This appendage of a very characteristic, boot-like shape (a character for which the species was named), with an auricle-like process antero-proximally. Ductus ejaculatorius narrow, forming a coil; its distal part surrounded by rather strong, chitinous walls.

Furca (Fig. 11): With 5 rather short, naked or almost naked bristles. (This figure refers to female, but agrees fairly well with that of male.)

Female: The above description agrees well with conditions in female, a fact evident from generic diagnosis.

Occurrence: This species was taken by the Swedish Antarctic Expedition at the following stations, all of which are located in South Georgia: Off mouth of Cumberland Bay (Sta. 34); depth, 252–310 m.; grey clay, with scattered stones; June 5, 1902: temp. at bottom, 1.45° C; type locality: 14 specimens, mature males and females, as well as 1 larva. Off mouth of May Bay (Sta. 22); depth, 75 m.; clay, with scattered algae; May 14, 1902; temp. at bottom, 1.5° C: 1 mature specimen. Off mouth of Moraine Fiord (Sta. 23); depth, 64–74 m.; grey clay with gravel and stones; May 16, 1902; temp. at bottom, 1.65° C: 1 larva. Off Grytviken (Pot Bay) (Sta. 24); depth, 95 m.; clay; May 20, 1902: 1 larva.

Remark: In his monograph of the Ostracods of the Challenger Expedition, G. S. Brady (1880, p. 146) described a single species of the genus *Cytherideis*, Jones, *viz.*, *C. lævata.* This species was unfortunately represented by empty shells alone, and was taken at Heard Island in the Antarctic Ocean. Judging by Brady's figures (Pl. 6:5; Pl. 35:6), it exhibits quite a striking similarity with the species described above. Whether it is a member of the genus *Copytus;* indeed, whether it is identical with my above species, is a question that can not be settled at present. The only character in which Brady's species differs from the one described above is the size, 0.77 mm. However, this difference may, of course, be due to possible immature nature of Brady's material. Considering the uncertainty in regard to the structure and systematic position of Brady's species, it was judged most advisable to avoid specific identification at present, pending further investigations.

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# THE BEES OF THE SOUTHERN CALIFORNIA ISLANDS*

BY

T. D. A. COCKERELL

*Professor Emeritus of Zoology*
*University of Colorado*

There are eight islands off the coast of Southern California, if we consider Anacapa to be one, and ignore the small islets such as Princess Island off San Miguel. Until collections were made in 1937 and 1938, hardly anything was known of the bee-fauna of these islands, although they are fairly rich in species, some of which are evidently endemic. In the following lists the species as yet known only from the islands are marked with an asterisk and the species known from more than one island are indicated by the abbreviations M. (San Miguel), Cz. (Santa Cruz), Ca. (Santa Catalina), Cl. (San Clemente) and N. (San Nicolas).

## (A.) NORTHERN GROUP

### San Miguel Island

*Bombus californicus* Sm (Ca.)
**Bombus nevadensis miguelensis* Ckll.
**Bombus crotchii semisuffusus* Ckll.
**Anthidium palliventre vanduzeei* Ckll.
*Osmia* sp.
*Anthophora edwardsii* Cress. (Ca.)
**Anthophora californica erysimi* Ckll.
*Tetralonia cordleyi* Vier (Ca.)
*Tetralonia robertsoni* Ckll.
*Emphoropsis miserabilis* Cress.
*Nomada edwardsii* Cress.
**Epeolus eastwoodæ* Ckll.
**Perdita layiæ* Ckll.
*Colletes californicus* Prov.
*Andrena complexa* Vier.
*Andrena perimelas* Ckll. (Ca.)

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**Agapostemon californicus psammobius* Ckll.
*Halictus pavonotus* Ckll.
**Halictus hammondi* Ckll.
*Halictus grinnelli* Ckll.
*Halictus nevadensis* Crawf.
**Halictus megastictus* Ckll.
**Halictus perichlorus* Ckll.
**Halictus punctiferellus* Ckll.
**Halictus pilosicaudus* Ckll. (N.)
**Halictus cabrilli* Ckll.
**Halictus miguelensis* Ckll.

On May 8, after collecting on San Miguel for a week, about an hour before sailing I found some plants of *Ranunculus* which had been overlooked. Visiting them were females of *Andrena complexa* Viereck, a regular buttercup species, an addition to the island fauna. One wonders how they got there, and how they found the *Ranunculus;* or do both date back to a time when the northern chain of islands was united with the mainland?

### Santa Rosa Island

A series of bees, not yet studied, was collected recently by the expedition from the Los Angeles Museum.

### Santa Cruz Island

*Augochlora pomoniella* Ckll. (Ca.)
**Diadasia mimetica* Ckll (Ca., Cl., N.)

On August 20, 1938, I had a few hours at Fry's Harbor. It was excessively dry, and the only bees I could catch were a pair of *Diadasia mimetica*, at flowers of *Opuntia littoralis*.

### Anacapa Island

*Anthidium maculosum* Cress.

## (B.) Southern Group

### Santa Catalina Island

*Bombus californicus* Sm. (M.)
*Bombus vosnesenskii* Rad.
*Bombus edwardsii* Cress.
*Bombus sonorus* Say.
*Alcidamea hypocrita* Ckll.
*Osmia clarescens* Ckll.
*Osmia regulina* Ckll.
**Anthidium catalinense* Ckll.
*Megachile* (only known by cut leaves)
**Dioxys catalinensis* Ckll.
*Cœlioxys* sp. (male, Meadows Coll.)
*Nomada semisuavis* Ckll.
**Nomada avalonica* Ckll.
*Nomada formula* Vier.
*Tetralonia cordleyi* Vier. (M.)
*Emphoropsis depressa* Fowler
*Anthophora stanfordiana* Ckll.
**Anthophora catalinæ* Ckll.
*Anthophora edwardsii* Cress. (M.)
*Dasiapis ochracea* Ckll.
*Exomalopsis nitens* Ckll.
**Diadasia mimetica* Ckll. (Cl., N., Cz.)
*Diadasia opuntiæ* Ckll. (Cl.)
*Melissodes lupina* Cress. (*catalinensis* Ckll.)
**Epeolus piscatoris* Ckll.
*Ceratina nanula rigdenæ* Mich.
*Colletes eriogoni* Ckll.
**Hylaeus polifolii catalinensis* Ckll.
**Diandrena gnaphalii* Ckll.
**Andrena escondida* Ckll.
**Andrena meadowsi* Ckll.
*Andrena perimelas* Ckll. (M.)
*Andrena auricoma* Sm.

*Andrena* n. sp. Timb.
**Andrena hypoleuca* Ckll.
**Andrena catalinica* Ckll.
*Andrena mimetica falli* Ckll.
*Andrena* sp. (Meadows Coll.)
*Agapostemon californicus* Crawf. (N.)
*Augochlora pomoniella* Ckll. (Cz.) (*pura*, err. det., Seavey, 1892)
**Halictus cooleyi obscurior* Ckll.
*Halictus nevadensis* Crawf. (M., Cl., N.)
*Halictus* n. sp. Timb.
*Halictus helianthi* Ckll.
*Halictus meliloti catalinensis* Ckll.
*Halictus ovaliceps* Ckll.
*Halictus incompletus* Crawf. (N.)
*Halictus* sp.
**Halictus avalonensis* Ckll. (Cl.)
*Apis mellifera* L. (introduced)

The species recorded as *Osmia regulina* is perhaps a race of *O. cobaltina* Cresson.

## San Clemente Island

**Anthophora catalinæ clementina* Ckll.
*Diadasia opuntiæ* Ckll. (Ca.)
**Diadasia mimetica* Ckll. (Ca., N., Cz.)
**Melissodes scotti* Ckll.
**Agapostemon californicus clementinus* Ckll.
**Halictus avalonensis* Ckll. (Ca.)
*Halictus nevadensis* Crawf. (Ca., M., N.)

## Santa Barbara Island

A few bees were collected by the expedition from the San Diego museum, and the account has been published by that museum. One subspecies of *Anthidium* is new.

## San Nicolas Island

**Anthophora nicolai* Ckll.
**Diadasia mimetica* Ckll. (Ca., Cl., Cz.)
*Agapostemon californicus* Crawf. (Ca.)
**Halictus pilosicaudus* Ckll. (M.)
*Halictus nevadensis* Crawf. (M., Ca., Cl.)
*Halictus incompletus* Crawf. (Ca.)

Some undetermined species in the above lists are represented by single specimens, and it is hoped that more material may be obtained.

The following records are new:

### **Anthophora nicolai** Cockerell, new species

Female (*Type*). With rufous hair as in *A. catalinæ* Ckll, but resembles *A. urbana* Cresson in lacking the black hair on sides of thorax and outer side of legs. The face is broader than in *A. urbana.*

Male. Similar to the San Clemente form of *A. catalinæ*, but hair on inner side of hind tarsi light ferruginous instead of black, and the white spot on mandibles much larger. The white face is like that of *A. urbana*, except that the black marks at sides of clypeus are a little larger, and the upper extension of lateral marks along orbit is more slender. The hair of the face is whitish, becoming dense and red in the region of the antennæ; that of the thorax above is red.

California: **San Nicolas Island,** July 7, 6, 9, 1938 (*Cockerell*). It visits *Abronia maritima* and *Mesembryanthemum crystallinum.*

## **Anthophora catalinæ clementina** Cockerell, new subspecies

Female (*Type*). Like *A. catalinæ* Ckll, but hind tibiæ and tarsi with hair all black, or it may be slightly pallid along posterior margin of tibia. The clypeus has black hair, and the sides of the thorax are black haired except the upper part.

Male. Similar to *A. urbana* Cresson, but with the hair usually much redder, that on the thorax above exceedingly rich deep red in some specimens. Thorax with reddish hair at sides, but black beneath (this is not so in *A. urbana*); face with whitish hair, red in region of antennæ and front; tibiæ and basitarsi with pale hair on outer side, on inner (posterior) side of middle and hind tibiæ and tarsi it is black, which is not at all true of *A. nicolai* or *A. urbana*. The white face is like that of *A. urbana*, but the black marks at sides of clypeus are much larger and longer, and the lateral marks are more deeply emarginate above.

California: **San Clemente Island,** June 17 to 21, 1938 (Cockerell, J. T. Scott). Common at Wilson's Cove; visits *Hemizonia clementina*, *Convolvulus macrostegius* (males), and *Mesembryanthemum crystallinum* (both sexes). The very red form of the male, contrasted with the palest, looks like an entirely different species; the pale form is superficially like *A. urbana*.

*A. catalinæ* was described from a single female taken by my wife on Catalina Island, August, 1901. In 1938, I left Catalina Island June 14, and returned Aug. 29. In the interval, *A. catalinæ* must have come and gone, for persistent search when we were on the island failed to produce a single specimen.

## **Melissodes scotti** Cockerell, new species

Female (*Type*). Length about 12 mm., resembling *M. hymenoxidis* Ckll, with the same black hair on pleura, and on front and middle legs, though the middle tarsi have light reddish hair, ferruginous on inner side. Much black hair on clypeus and front but a tuft of long pale hair at each side of upper part of face, a character more or less apparent in *M. hymemoxidis;* cheeks and occiput with white hair, but long, black hair on vertex; flagellum bright ferruginous beneath, except at base; thorax anteriorly with a broad, sharply defined collar of pale fulvescent pubescence, but the rest of the mesonotum, as well as the scutellum, is clothed with long black hair (much less black hair in *M. hymenoxidis*); region behind wings with pale hair; tegulæ black, with a tuft of black hair; wings dusky; stigma and nervures black (much paler in *M. hymenoxidis*); scopa of hind tibiæ and tarsi pale reddish, very copious; abdomen with black hair, but second tergite with a thin band of pale at extreme base, and a dense, entire, pale fulvescent band apically; third and fourth tergites with fulvescent bands like that on second; apex with dark hair, a little pale reddish at each side of apical plate, which is more slender and produced than in *M. hymenoxidis*. The thorax is appreciably more robust than in *M. hymenoxidis*.

California: **Wilson's Cove, San Clemente Island,** June 17, 1938 (J. T. Scott.)

### **Melissodes lupina** Cresson

California: Santa Catalina Island, Pebbly Beach, June 4, female at *Malacothrix saxatilis* Nuttall, (Cockerell); Fisherman's Cove, June 9, both sexes (*W. P. Cockerell, Cockerell*). At the latter place it occurred resting in flowers of *Calochortus*, and one was taken on *Sinapis*. I had only the male of *M. lupina*, and the female of *M. catalinensis* (Ckll), but they are one species, as Timberlake pointed out to me.

### **Dasiapis ochracea** Cockerell

California: Santa Catalina Island, Fisherman's Cove, June 9, (*W. P. Cockerell, Cockerell*). Many males resting in flowers of *Calochortus;* one at flowers of *Opuntia littoralis*.

### **Exomalopsis nitens** Cockerell

California: described from Laguna, and I have a pair from Westwood Hills, June and August (E. G. Linsley). On Catalina Island, my wife took two at Rancho Escondido, June 6, both males, at flowers of *Opuntia littoralis*, and I took a female at the same locality, resting in a flower of *Bloomeria crocea*. On June 9, we found the species common at Fisherman's Cove, both sexes resting in the flowers of *Calochortus*. On June 11, a female was taken in Cape Canyon at flowers of *Malvastrum catalinense*.

### **Augochlora pomoniella** Cockerell

California: abundant on Santa Catalina Island, first appearing March 31. In Cape Canyon, Aug. 30, both sexes were numerous on flowers of *Eremocarpus setigerus*. On Sept. 1, near the highest point on the road, a female was taken at flowers of *Eriogonum giganteum*. At Rancho Escondido, March 31, it was taken on *Encelia californica*.

### **Agapostemon californicus clementinus** Cockerell, new subspecies

Male (*Type*). Like the specimen of *A. c. psammobius* Ckll. from Princess Island, with strongly blue mesothorax, and yellow band on first tergite broadly interrupted, or sometimes very narrowly continuous. The genitalia are entirely of the *A. texana* type (as figured by Miss Sandhouse).

Female. Like *A. c. psammobius*, but very blue; tegulæ very dark; sculpture of metathorax delicate.

California: Common on **San Clemente Island** (*Cockerell, J. T. Scott*), middle of June, both sexes at flowers of *Convolvulus macrostegius* and *Hemizonia clementina.* Female at *Mesembryanthemum crystallinum.* Crawford, in his original account of male *A. californicus*, says "head and thorax blue above," and the race now described might be referred to the typical form without much difficulty, so far as described characters go. The genitalia appear to separate it from the very similar *A. c. psammobius*, from San Miguel Island. However, *A. californicus* is very common on the mainland, and is emerald green in the female like *A. texanus*, with which Miss Sandhouse proposes to unite it. The whole series from San Clemente is remarkable for the rich purple-blue colour in both sexes, and contrasts strongly with specimens from Santa Catalina and San Nicolas Islands, the females from these islands being green, and quite like the common form on the mainland, for example at La Jolla. On San Nicolas, in July, I got only females of *A. californicus* Crawford; they were at flowers of *Opuntia littoralis* and *Mesembryanthemum crystallinum.*

### **Nomada formula** Viereck

California: Santa Catalina Island, Fisherman's Cove, at flowers of *Sinapis*, June 9 (*W. P. Cockerell*).

### **Nomada semisuavis** Cockerell

California: Santa Catalina Island, Pebbly Beach; both sexes taken, June 4 and 13 (*W. P. Cockerell*). It visits flowers of *Malacothrix saxatilis.* Previously known from Washington State, far to the north. I have a male taken at Avalon, Catalina Island, by Don Meadows, Aug. 28, 1929.

### **Epeolus piscatoris** Cockerell, new species

Female (*Type*). Length about 8 mm; black, including mandibles, antennæ, tegulæ and legs, except that the small joints of tarsi are obscurely rufescent; eyes green; pale pubescence tinged with brown; clypeus with fine dense punctures and scattered larger ones, a median line obscurely indicated; dense pale hair in region of antennæ and at sides of upper part of face; a band of pale hair on upper part of cheeks; mesothorax margined at sides and behind with pale hair, and two strong parallel bands on disc; mesothorax and scutellum densely punctured; mesopleura except lower part, covered with coarse pale hair; wings dusky, with black nervures; second cubital cell very narrow above, very broad below, receiving recurrent nervure about middle; spurs black, middle and hind tibiæ with pale hair on outer side; hair on inner side of hind basitarsi pale reddish; first tergite with a broad transverse black band, its lateral corners acute; apical hair-band on same tergite broad, with a linear interruption; lateral corners of black area on second tergite very acute; each side of end of abdomen with a large patch of thin pale hair; venter black, the second and third sternites with white bands at sides.

California: **Santa Catalina Island,** Fisherman's Cove, at flowers of *Sinapis*, June 9, 1933 (W. P. Cockerell). In my table in University of Colorado Studies, XVI, p. 106, it runs out at 14, on account of the interrupted, broad band on second tergite. By the hairy pleura and black spurs it resembles *E. bihamatus* Ckll., which differs by the flagellum red beneath and other characters. In the table in Proc. Calif. Acad. Sci., 4th Ser. Vol. XIII, 1924, p. 321, it runs out at 7, distinguished by the black legs. In the table in Am. Mus. Novitates, no. 23, it runs out at 8. Timberlake has never seen it in Southern California.

## **Anthidium catalinense** Cockerell, new species

Male (*Type*). Length about 14 mm., anterior wing 10; black, with sulphur yellow markings, which include mandibles except the tridentate apex, entire clypeus (which has a dull surface), lateral marks (filling space between clypeus and eye, and extending upward to level of antennæ), a cuneate mark above each eye, large spot on tegulæ in front (but no marks on thorax), middle tibiæ with a quadrate spot at apex, and small line at base; hind tibiæ with an interrupted stripe on basal half, stripe on outer side of basitarsi, four large spots on tergites 1 to 3, on 4 and 5 they are narrowly united on each side, the sixth has a band with linear interruption, but the seventh is all black. Pubescence mostly clear white, but reddish brown on head and thorax above; front and vertex dull, and very densely punctured; mesonotum dull, scutellum shining in middle posteriorly; base of metathorax shining in middle; wings strongly dusky; lateral apical lobes very broadly dentiform, triangular, the apical point directed mesad; median spine not extending to level of ends of lobes; subapical median process strongly bidentate.

Female. Length about 12 mm.; hair of head and thorax above paler; clypeus with two very large yellow marks, separated by a narrow interval, the upper end of each mark rectangular; no lateral marks; cuneiform marks above eyes long, longer than the interval between them; a small yellow spot above tegulæ, a yellow spot on tubercles, and a couple of transverse marks on scutellum; legs black, the front and middle basitarsi brilliantly white from a covering of hair; hind tarsi with red hair on inner side and white on outer, bright yellow band on first tergite interrupted in middle and emarginate posteriorly on each side; second tergite with four spots; on tergites 3 to 5 the spots are united laterally; the sixth tergite has two large quadrate yellow marks; ventral scopa clear white.

California: **Santa Catalina Island,** the male from **Fisherman's Cove,** in a flower of *Calochortus*, June 9 (*W. P. Cockerell*); female from Pebbly Beach, June 13 (*Cockerell*). The sexes appear to be correctly associated, but proof is lacking. The species could not be matched at the Citrus Experiment Station of the University of California. In the table by Schwarz in Am. Mus. Novitates, 253, the male runs to *A. tenuifloræ* Ckll., which is smaller, with much paler markings. The female runs to *A. palmarum* Ckll., differing in the colour of the legs and other characters; the markings on tergites 3 to 6 resemble those of *A. porteræ* Ckll.

### **Halictus pilosicaudus** Cockerell

California: San Nicolas Island, at flowers of *Malacothrix implicata* and *Mesembryanthemum crystallinum*, July 8 to 15 (*Cockerell*). Previously known only from San Miguel Island.

### **Halictus meliloti catalinensis** Cockerell

Common on Santa Catalina Island, new localities are Fisherman's Cove, at flowers of *Calochortus* and *Sinapis;* and Cape Canyon, at flowers of *Opuntia littoralis*.

### **Halictus incompletus** Crawford

California: Mr. Timberlake, being very familiar with this small species in southern California, was able to sort out no less than 21 specimens from my recent island collections; the data are as follows: San Nicolas Island, July, at *Mesembryanthemum crystallinum*, *Hemizonia clementina*, and *Heliotropium oculatum*.

Santa Catalina Island: Fisherman's Cove, many at flowers of *Sinapis* (*W. P. Cockerell*), and we found them resting in flowers of *Calochortus*. Isthmus, Aug. 31 (*Cockerell*). Rancho Escondido, June 6 (*W. P. Ckll.*, *Ckll.*), female at *Opuntia littoralis*, both sexes flying round *Salvia mellifera*.

### **Halictus nevadensis** Crawford

The following were referred here by Timberlake:

San Nicolas Island, July 9 (*Ckll.*). At *Mesembryanthemum crystallinum*.

San Clemente Island, Wilson's Cove, June 21 (J. T. Scott).

Santa Catalina Island, Pebbly Beach, June 4 (W. P. Ckll.).

### **Halictus helianthi** Cockerell

Santa Catalina Island, Avalon, at flowers of *Chrysanthemum frutescens*, the Marguerite daisy, Sept. 1, (*Cockerell*). Cape Canyon, June 11 (*Ckll.*), at *Opuntia littoralis*. There are two other species of the subgenus *Chloralictus* in the collection. One, near *H. nevadensis*, is represented by a single specimen from Rancho Escondido; the other, with four from Fisherman's Cove and one from Rancho Escondido, is a species well-known to Timberlake from the mainland, and named by him in manuscript after Fowler.

**Halictus cooleyi obscurior** Cockerell, new subspecies

Female (*Type*). Compared with a paratype *H. cooleyi* Crawford, from Corvallis, Oregon, it differs by the much duller, less polished mesonotum, the dark tegulæ and the smaller head.

Male. Smaller than my males of *C. cooleyi*, and distinguished by the total lack of hairy fringes on the subapical sternites of abdomen.

California: **Santa Catalina Island, Cape Canyon** (type locality), June 11, at *Opuntia littoralis*, females, (*Ckll.*); Fisherman's Cove, at *Sinapis*, June 9, both sexes (*W. P. Ckll.*); Avalon, June 8, at *Chrysanthemum frutescens*, (*Ckll.*).

**Halictus avalonensis** Cockerell

Santa Catalina Island; a female in flower of *Calochortus*, Fisherman's Cove, June 9 (*W. P. Ckll.*). The male, hitherto unknown, is represented by a series as follows:

Santa Catalina Island, at *Sinapis* and *Calochortus*, Fisherman's Cove, June 9 (*W. P. Ckll.*); Avalon, June 8, at *Chrysanthemum frutescens*, (Ckll.).

San Clemente Island; three at flowers of *Convolvulus macrostegius*, June 18 (*Ckll.*); Wilson's Cove, two at *Hemizonia clementina*, June 21 (*J. T. Scott*).

The male has lower part of clypeus, spot on mandibles, and labrum cream color; face with white hair; antennæ very long, flagellum variably reddened beneath; stigma sometimes very dark; anterior tibiæ pale reddish in front; tarsi yellowish-white, more or less rufescent apically. In Crawford's table (1907) it runs to 19, and here should doubtless go in the group with dark tubercles, but the tubercles have a very minute light spot in the Scott specimen from San Clemente, in the Calochortus one from Fisherman's Cove, and in the specimens from Avalon. The dull mesonotum would place it with *H. niger* Viereck, which is a much larger species, or with *H. cordleyi* Crawford, which is also larger and more robust. I know only the female of *H. cordleyi;* it differs from that sex of *H. avalonensis* by its much more robust form and duller clypeus.

**Ceratina nanula rigdenæ** Michener

Santa Catalina Island; Cape Canyon, Aug. 30, three females (W. P. Ckll.). It visits flowers of *Eremocarpus setigerus*. It was probably this which Seavey (1892) recorded as *C. acantha* Provancher.

### **Andrena mimetica falli** Cockerell

Santa Catalina Island; Avalon, females abundant at *Cotoneaster*, June 3 to 5 (*W. P. Ckll.*, *Ckll.*). A new species of *Andrena* (named in manuscript by Timberlake, who found it on the mainland) was taken at Middle Ranch.

### **Bombus sonorus** Say

Santa Catlina Island; White's Landing, April 13, and Avalon, Sept. 11 (*D. Meadows*); Cape Canyon, June 11, visiting *Solanum douglasii* (*W. P. Ckll.*, *Ckll.*). Later in the year it was very abundant.

*B. edwardsii* Cresson, *B. vosnesenskii* Rad., and *B. californicus* Smith were also taken at Avalon. The males of *B. edwardsii* were at cultivated *Statice*, March 21 and April 1. *B. vosnesenskii* was taken at Rancho Escondido, June 6 (W. P. Ckll.).

### **Osmia clarescens** Cockerell

Santa Catalina Island; Rancho Escondido (Ckll.), June 6. Females visiting *Astragalus leucopsis*.

I am greatly indebted to Mr. P. H. Timberlake of the Citrus Experiment Station of the University of California with whom I examined most of the bees from the islands, and his critical judgment has gone far to fortify the determinations. At the same time, he must not be held responsible for my decisions.

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No. 29

# THE NEOTROPICAL ANCHOVIES OF THE GENUS *AMPLOVA**

BY

GEORGE SPRAGUE MYERS

*Stanford University, California*

The anchovies, particularly those of Tropical America, with their nomenclature, long were a perplexing problem, and few ichthyological papers of recent years have been more welcome than Jordan and Seale's *Review of the Engraulidæ*.[1] Its receipt prompted me to an examination of the Amazonian anchovies in the collection of Indiana University[2], which the late Dr. Eigenmann had asked me to identify. Aside from numerous *Lycengraulis batesii* (Günther), from Santarém and Lagoa Grande between Santarém and Obidos, these consisted principally of small fishes referable to the group called *Amplova* by Jordan and Seale. Examination of them and search through the literature made it appear best to include references to all the described species of *Amplova*, especially since Jordan and Seale mention but three of the forms in their paper. A formal revision is not attempted, however, due to lack of material of several of the species.

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*Printed from the John W. Hendrie Endowment.

[1] Bull. Mus. Comp. Zool., lxvii, 1926, pp. 355–418.

[2] Now in the California Academy of Sciences, San Francisco. I am greatly indebted to Dr. Barton Warren Evermann, Director of the Museum of the Academy, for permission to publish on this material. The present paper was written at Indiana University, at the instigation of the late Dr. Eigenmann, in 1926.

December 31, 1940.

## **Amplova** Jordan and Seale

GENOTYPE: *Anchovia brevirostra* Meek and Hildebrand = *Amplova balboæ* Jordan and Seale.

This genus is characterized by the compressed, keeled venter, without scutes; the separate gill-membranes; the low number of gill-rakers on the lower limb of the first arch (30 or fewer in the known species); the low number of vertebræ (under 46); the small mouth and short snout; and the short, curved maxillary, broad and rounded terminally.

Jordan and Seale assign three species to the genus, *Anchovia brevirostra* Meek and Hildebrand (*Amplova balboæ*), recently described from Balboa, Panama; *Engraulis brevirostris* Günther, from "Caxoeira", Brazil; and a new species from the Amazon, *Amplova jamesi* Jordan and Seale. Four others are here added. The following synopsis should be used with caution, for we know little of the variation of these forms.

*Synopsis.*

1a. Deep, depth contained 4 times or less in standard length.

  2a. No silvery lateral band; dorsal origin midway between front of eye and caudal base. (Pacific coast of Panama).

   1. *A. balboæ.*

  2b. A silvery lateral band; dorsal origin midway between snout tip and caudal base. (Coast of Guiana).

   2. *A. lepidentostole.*

1b. More slender, depth 4.33 or more in standard length.

  3a. Head large, 3.57 to almost 4 in standard length; depth 4.33 to 4.80. (Rio São Francisco).

   3. *A. vaillanti.*

  3b. Head smaller, 4 to 4.5; depth less, 5.17 to 6 in standard length.

   4a. Depth 5.17 to 5.40.

    5a. Head 4.5; pectoral terminating at a great distance from pelvics; dorsal origin midway between snout tip and caudal base; anal origin below last part of dorsal. (Coast of Bahia).

     4. *A. brevirostris.*

    5b. Head little more than 4; pectorals not reaching pelvics by half eye diameter; dorsal origin midway between caudal base and snout tip; anal origin under tenth dorsal ray; body greatly compressed; size up to 60 mm. (Amazon and Guiana).

     5. *A. guianensis.*

    5c. Head 4.5; pectorals not reaching pelvics by half eye diameter; dorsal origin half eye diameter nearer snout tip than caudal base; anal entirely behind dorsal; body not greatly compressed, oval in section; up to 88 mm. (Marañon).

     6. *A. alleni.*

   4b. Depth 6; anal 22. (Amazon).

     7. *A. jamesi.*

### 1. **Amplova balboæ** Jordan and Seale

*Anchovia brevirostra* Meek and Hildebrand, Marine Fishes of Panama, Part 1, 1923, p. 198, pl. 12, fig. 1 (Balboa, Pacific Coast of Panama) (not *Engraulis brevirostris* of Günther).

*Stolephorus brevirostris* Hildebrand, Bull. Bur. Fisher., Washington, xli, 1925, p. 284 (Cutuco, Salvador).

*Amplova balboæ* Jordan and Seale, Bull. Mus. Comp. Zool., lxvii, 1926, p. 411 (substitute name).

Head 4.3 to 4.6; depth 3.5 to 4; dorsal 11 to 14; anal 23 to 27; scales 35 to 40 laterally; rakers 25 to 30 on lower limb of first arch; dorsal origin midway between anterior margin of eye and base of caudal; insertion of anal under middle of dorsal; pectorals reaching almost to base of pelvics; color pale silvery, without a lateral band. (*Condensed, after Meek and Hildebrand*).

This species differs from all the others in the absence of the characteristic brilliant silvery lateral band. In other characters it is scarcely to be distinguished from *A. lepidentostole.* The figure given by Meek and Hildebrand, a photograph, shows the pectoral well overlapping the pelvic base, contrary to the description. Probably a mistake was made in cutting out the photograph for mounting, a little of the background having been left at the pectoral tip. The axillary pectoral flap is not nearly as long as that of *lepidentostole*, and the dorsal origin is very slightly further forward. *A. balboæ* is the only known Pacific Coast representative of the genus.

### 2. **Amplova lepidentostole** (Fowler)

*Anchovia lepidentostole* Fowler, Proc. Acad. Nat. Sci. Phila., 1911, p. 214, fig. 3 (Surinam).

Head 4.25; depth 4; dorsal 16; anal 26; scales 35 laterally; rakers 18+25; dorsal origin midway between snout tip and caudal base; anal origin about opposite first third in dorsal length; pectoral .75 to pelvic; a broad silvery lateral band, about equal to eye diameter, becoming a little constricted at shoulder and along side of caudal peduncle; 4 inches. (*Condensed, after Fowler*).

Fowler well figures the characteristic maxillary of *Amplova*, and there is no doubt the species belongs here, close to *balboæ.* These two form a group distinguished from the others by the greater depth and compressed body. Both are probably brackish-water forms.

### 3. **Amplova vaillanti** (Steindachner)

*Engraulis vaillanti* Steindachner, Anz. Akad. Wiss. Wien, xlv, 1908, p. 193 (Joazeiro and Barra on Rio São Francisco; Rio Grande do Norte; Rio Preto).

*Stolephorus vaillanti* Eigenmann, Repts. Princeton Univ. Exped. Patagonia, iii, 1910, p. 451 (name only).

*Anchovia vaillanti* Starks, Fishes Stanford Exped. Brazil, 1913, p. 10. (name only).

Head 3.57 to almost 4; depth 4.33 to 4.80; dorsal 12 or 13; anal 22 to 25; scales 35 to 38 laterally; 18 to 19 rakers on lower limb of first arch; dorsal origin always falling before middle of the body length, without caudal; anal origin on vertical of last dorsal ray; pectoral tip reaching almost or exactly to pelvics; a sharply defined silvery lateral band; a faint dark band or a small spot at the caudal base. (*Translated and condensed, after Steindachner.*)

I have examined a single specimen in Indiana University[3], collected by J. D. Haseman at Barra, Rio São Francisco, whence came Steindachner's types. It agrees well with the above account; dorsal 12, anal 20. Close to *A. alleni* but well distinguished by the longer head, deeper and more compressed body, longer anal, and the extent of the pectoral fins.

## 4. **Amplova brevirostris** (Günther)

*Engraulis brevirostris* Günther, Cat. Fish. Brit. Mus., vii, 1868, p. 392 ("Caxoeira" in Prov. Bahia, Brazil); Jordan and Seale, Bull. Mus. Comp. Zool., lxvii, 1926, p. 411 (name only).

*Stolephorus brevirostris* Eigenmann, Repts. Princeton Univ. Exped. Patagonia, iii, 1910, p. 451 (name only).

Head 4.5; depth 5.33; eye 3.5 in head; dorsal 15; anal 18; scales 41 laterally; dorsal origin midway between end of snout and root of caudal; anal origin below posterior part of dorsal; pectoral terminating at a great distance from pelvics; abdomen slightly compressed; 3.5 inches. (*Condensed, after Günther.*)

Apparently not recognized since described, unless what I call *guianensis* is the same.

## 5. **Amplova guianensis** (Eigenmann)

*Stolephorus guianensis* Eigenmann, Mem. Carnegie Mus., v, 1912, p. 447, pl. 62, fig. 5 (Bartica Grove; Morawhanna; Demerara Flats).

*Anchovia brevirostris* Pearson, Indiana Univ. Studies, No. 64, 1925, p. 50 (Lake Rogoagua, Bolivia) (not of Günther).

Head slightly more than 4; depth 5.16, eye 3.5; dorsal 14 or 15; anal 17 to 19; scales deciduous, about 38 laterally; rakers 22, longest 1.33 in eye, narrow, pointed, with fine spinules interiorly; dorsal origin midway between caudal base and snout tip, longest ray 1.25 as long as fin base; anal origin under about the tenth dorsal ray; pectorals not reaching pelvics by half eye diameter; pelvics inserted considerably in advance of dorsal, midway between pectoral insertion and anal fin; length of caudal peduncle .8 head; body much compressed; pale straw colored; a more or less diffuse silvery line down the side; occiput dark.

Here described from numerous specimens, up to 60 mm., Lagoa Grande, on lower Amazon near Obidos, Dr. Carl Ternetz. I have compared them with the paratype from Morawhanna, I. U. No.

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[3] Now in The California Academy.

12562, and with Pearson's specimens, No. 17354. All seem to represent the same species. Dr. Eigenmann gives the dorsal as equidistant from snout and caudal or nearer the former, anal 18, dorsal 13. Whether or not this fish is the same as *A. brevirostris* (Günther) remains to be seen. The head length and the extent of the pectorals would seem to differ.

### 6. **Amplova alleni** Myers, sp. nov.

Head 4.5 in body length; depth 5.4; eye 3.66 in head; dorsal 14; anal 18; pelvics 7; scales deciduous, 36 to 39 laterally, mostly lost; rakers 22 on lower limb of first arch, longest 1.8 in eye, narrow, pointed, with fine spinules interiorly; dorsal origin half an eye diameter nearer snout tip than to caudal base, the longest ray 1.25 times as long as fin base; anal entirely behind dorsal, its origin on the vertical of last dorsal ray to half an eye diameter posteriorly; pectorals not quite reaching pelvics (by half an eye diameter); pelvics inserted considerably in advance of dorsal, midway between hind border of opercle and anal origin, the tips reaching vertical of fifth dorsal ray; length of caudal peduncle equals head; body thick and oval in cross-section, differing greatly in this from *guianensis;* a sharply defined brilliant silvery lateral stripe from head to caudal, narrow at the head, broadening to the width of the eye over the anal, and narrowing slightly on the caudal peduncle; occiput black; several rows of dark chromatophores down midline of back; caudal dark bordered.

Contamana, Rio Ucayale, Peru. August, 1920. W. R. Allen. Eleven specimens, 68 to 88 mm. total length.

Lake Cashiboya, Rio Ucayale, Peru. August, 1920. W. R. Allen. Six, 84 to 87 mm.
Gosulima Cocha, Upper Rio Morona, Peru. W. R. Allen. One, 84 mm.
Rio Morona, Peru. W. R. Allen. One, 76 mm.

*Holotype:* No. 6421, standard length 68 mm. Mus. Calif. Acad. Sci. Ichthyol. **Lake Cashiboya,** Peru, Aug. 1920, W. R. Allen, Coll.

This fish is distinguished from *guianensis* principally by the less compressed form and much greater size, and from *brevirostris* by fin positions and extent of pectoral fin. It is the common anchovy of the Marañon.

I take pleasure in naming this species for the collector, Dr. William Ray Allen, of the University of Kentucky.

### 7. **Amplova jamesi** Jordan and Seale

*Amplova jamesi* Jordan and Seale, Bull. Mus. Comp. Zool., lxvii, 1926, p. 410 (Jutahy River; Lago Alexo).

Head 4; depth 6; dorsal 12; anal 22; scales 38 laterally (approximate); rakers 20 on lower limb of first arch; dorsal origin midway between middle of opercle and caudal base; anal origin below fifth dorsal ray; pectorals reaching pelvics; a diffuse indistinct lateral silvery stripe. (*Condensed, after Jordan and Seale.*)

Apparently well distinguished from all the other species by the position of the dorsal and the slender form. Two very small specimens of an elongate anchovy from the Rio Ucayale, collected by Dr. Allen, may belong here.

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I was unable to place satisfactorily numerous young anchovies collected by Dr. Allen in the Rio Morona. They may represent the young of *A. alleni* but they have the more compressed body of *A. guianensis*. The thick body of *alleni* may be an adult character. The specimens have the dorsal origin midway between snout tip and caudal base and dorsal 12 or 13, anal 18 or 19. Possibly they really are *guianensis*.

*Stolephorus manjuba*, Miranda Ribeiro, Peixes da Ribeira, *Kosmos*, Rio de Janeiro, V. 1908, (no pagination), may be an *Amplova*. Dr. Hildebrand thinks it may be the young of *Cetengraulis edentulus*.

Miranda Ribeiro has several times recorded *Lycengraulis* ("*Stolephorus*") *poeyi* Kner and Steindachner from the fresh waters of Brazil. As that species is a marine form known only from the Pacific side of Panama, there evidently must have been a misidentification, possibly of the closely related *L. batesii* (Günther).

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**No. 30**

# NOTES ON A CALIFORNIA EARTHWORM, PLUTELLUS PAPILLIFER (EISEN, 1893)*

BY
GORDON E. GATES
*Judson College,*
*Rangoon, Burma*

The genus *Plutellus* Perrier, 1873, comprises species from Pennsylvania, Guatemala, the western coast of the United States, Queen Charlotte Island, Australia, Tasmania, New Caledonia, Auckland Islands, Burma, India and Ceylon. Such a distribution, in view of the "polyphyly" so prevalent in the Megascolecidæ, is sufficient reason for suspicion that *Plutellus* may also be an aggregation of species that should be split into morphologically homogeneous, "monophyletic" genera of a more orthodox nature. Such a revision, if necessary, is impossible at present as most if not all of the species are inadequately characterized.

Four species have been erected for Californian forms. Each species, except for notes of uncertain value on the penial setæ of two forms, is known only from the original descriptions. Types of three of the species were destroyed at the time of the earthquake in 1906. One or more specimens of two of these species, identified by the author (Eisen), may be in the Hamburg Museum which has the immature types of the fourth species. Type localities of three species are undesignated. As a result of mistakes or omissions in earlier accounts

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and lack of information as to variation in characteristics of taxonomic importance none of the Californian species can be adequately defined at present.

The worms which provided the material for this article are from a small collection forwarded by Dr. A. W. Herre of Stanford University. In addition to the Plutelli described below, this collection comprises a number of unidentifiable juveniles, ten clitellate specimens of *Allobophora caliginosa* f. *trapezoides* (Savigny) 1826, and one clitellate specimen of *Octolasium lacteum* Örley 1881. The author's thanks are extended to Dr. Herre for the collection, preservation in good condition and forwarding of the specimens.

## **Plutellus papillifer** (Eisen) 1893

*Argilophilus marmoratus papillifer* Eisen, Zoe, IV, 1893, p. 253. (No types. Type locality not designated. Berkeley, San Francisco, Monterey, Palo Alto, San Joaquin Valley.)

*Argilophilus marmoratus papillifer*, Eisen, Mem. California Acad. Sci., II, (3), 1894, p. 55. (South of San Francisco Bay; Santa Rosa, Santa Clara, Monterey, Fresno and Nevada counties.)

*Megascolides papillifer*, Beddard, Monog. 1895, p. 495.

*Plutellus papillifer*, Michælsen, Das Tierreich X, 1900, p. 166.

*Plutellus papillifer*, Michælsen, Ark. Zool. XIII, (19), 1921, p. 11. (Notes on penial setæ of a specimen from Oakland identified by Eisen. One or more specimens identified by Eisen may be in the Hamburg Museum.)

*Material examined.* Two juvenile and one clitellate specimens labelled, "In loam, Mt. McPherson, Castle Rock Ridge, Santa Cruz Mts., Santa Cruz Co., Calif. Elevation 3100 feet. January 14, 1939. Coll. Albert W. Herre."

One clitellate specimen labelled, "On wooded slopes in forest above Woodside, San Mateo Co., Calif. Elevation about 1,000 feet. May, 1939. Coll. Albert W. Herre.".

Three clitellate specimens labelled, "In soil, rather sandy loam. Mt. McPherson, Castle Rock Ridge, Santa Cruz Mts., Santa Cruz Co., Calif. Elevation 3,100 feet. March 4, 1939. Coll. Albert W. Herre."

*External characteristics.* Length 85–155 mm. Diameter four to six mm. Unpigmented (formalin preservation), clitellar colouration reddish. The prostomium is epilobous but with no transverse furrow at the posterior end of the tongue.

Setæ begin on ii, on which all four couples are present. On segments just behind the clitellum $ab$ *ca.* = $\frac{1}{2}$ $bc$, $bc$ and $aa$ *ca.* = both $bc$ and $aa$ a trifle smaller than $cd$, posteriorly $dd < \frac{1}{2}C$. Setæ, at least in the preclitellar segments, are ornamented ectally with numerous, fairly closely crowded, transversely placed rows of fine teeth. Setal lines (longitudinal) are only slightly, if at all, dislocated mesially on clitellar segments.

Nephropores begin on ii and are variable in position, located on anterior segments of certain specimens as follows: ii–x and xii–xiii on $d$, xiv on $c$; ii–vi on $d$, vii–viii on $c$; vii on $c$, viii on $d$–left, on *c*–right, ix on *d*–left, on *c*–right, x–xii on *c*, xiii on *d*–left, on *c*–right, xiv on *c*–left, on *d*–right.

The clitellum is saddle-shaped, extending from 12/13 to 18/19 or slightly onto xix and ventrally to or almost to *b;* sites of intersegmental furrows slightly indicated, dorsal pores lacking, setæ present. The clitellum may be constricted (clitellar segments slightly narrower than pre- and postclitellar segments) or slightly protuberant, the colouration very faint, faint or marked.

Dorsal pores are small, recognizable only with difficulty on the postclitellar portion of the body, beginning on 18/19 (1) or 19/20 (2).

Spermathecal pores are present on one worm only, and are rather small, transversely placed, shortly elliptical apertures with centres on *b*, each aperture filled with a translucent material. Each pore is located at or near the centre of a sharply demarcated, transversely placed, tumescent area of approximately elliptical outline, intersegmental furrows 7/8 and 8/9 lacking on the tumescences, pores on approximate sites of and in line with the furrows.

Female pores are minute, on or just median to *a*, about midway between the setal arc and 13/14.

Male pores are minute, longitudinally placed, straight or crescentic slits (in the latter case with concave side mesially) on *b* of *xviii*. Appertures of *a* follicles of xviii are dislocated laterally, of *b* follicles mesially, the male pores closer to the apertures of the *b* follicles than the apertures of the follicles are to each other, the sites of male pores not readily recognizable and apertures visible only with slight traction on neighbouring epidermis under best optical conditions. Male pores and apertures of penisetal follicles are located on paired, transversely placed, indistinctly demarcated areas of approximately elliptical outline, extending from just median to *a* slightly into *bc*, the surface convex, each porophore apparently restricted to a middle, secondary annulus (if the usual two, secondary furrows were present). The porophores are connected on one specimen only by a transverse, midsegmental ridge, apparently the result of some special contraction, as there is no trace of any such ridge or of epidermal thickening in *aa* of other worms. Immediately anterior and posterior to each porophore is a transversely placed area of thickly crescentic outline, the concave sides facing the male porophore. These lunate areas may be opaque, sharply demarcated and tumescent, or depressed, greyish translucent and indistinctly demarcated, reaching slightly further mesially and laterally than the male porophores, and possibly extending slightly onto xvii and xix (in some specimens with an appearance of dislocating anteriorly or posteriorly 17/18 and 18/19, though the furrows are lacking in *ab*).

Genital markings are unpaired, median, transversely placed areas of shortly elliptical to shortly spindle-shaped outline, in *aa*, reaching laterally on each side halfway to *a* or slightly less. Markings may be tumescent, rather conspicuously protuberant and sharply demarcated as on aclitellate specimens, or indistinctly demarcated and depressed. In the former condition each marking has a wide, opaque, marginal band and a greyish, translucent, central area.

### Genital Markings

| *Specimen* | *Intersegmental furrow* | | | | | | | | | | | | | *Locality* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 9/10 | 10/11 | 11/12 | 12/13 | 13/14 | 14/15 | 15/16 | 16/17 | 17/18 | 18/19 | 19/20 | 20/21 | 21/22 | |
| 1 | + | + | + | + | − | + | − | + | − | − | + | + | − | Mt. McPherson |
| 2 | + | + | + | + | − | + | + | + | − | − | + | + | − | " |
| 3 | + | + | − | − | − | + | − | − | − | − | + | + | − | " |
| 4 | + | + | + | − | − | + | + | + | − | − | + | + | + | Woodside |
| 5 | + | + | + | + | − | + | − | + | − | − | + | + | − | Mt. McPherson |
| 6 | + | + | + | + | − | + | + | + | − | − | + | + | − | " |
| 7 | + | + | + | + | − | + | + | + | − | − | + | + | − | " |

*Internal anatomy.*—Septum 5/6 is very delicate and transparent; 6/7 slightly muscular; 7/8–10/11 thickly muscular, 11/12–13/14 muscular; 14/15–16/17 with muscular fibres but quite translucent; 5/6–10/11 or 11/12 funnel-shaped with apices posteriorly.

The large gizzard is in v (7), 6/7 attached to the gut quite definitely behind the gizzard. Septum 5/6 passes to the anterior margin of gizzard, but is not adherent there, and with care can be lifted off to a region of attachment at or just behind the posterior margin of the gizzard. In vi–ix the œsophagus is narrow and white, in x–xiv widened and dark brown, except for a white, median band on the ventral face that is slightly narrowed posteriorly, in xv–xvi brown ventrally as well as dorsally and laterally, the ventral wall of the gut quite obviously thicker than the dorsal wall. The inner face of the gut in x–xiv is provided with numerous, closely crowded, rather irregular, longitudinally placed, slightly lamelliform, white ridges. Midventrally the floor of the gut in this region is raised to form a rather conspicuous and fairly wide ridge which may have a smooth flat surface, or a longitudinally placed groove of variable depth. In one worm the margins of the groove are dark red. The narrow, white, œsophageal valve is anteriorly in xvii, with straight, longitudinal ridges on the inner wall (4 specimens, unrecognizable because of distention in 3). The intestine begins posteriorly in xvii (4).

Septum 17/18 is attached to the intestines slightly behind the origin, and cannot be dissected off anteriorly. The typhlosole, which begins in xxvii (5), is a slightly zigzagged, lamelliform ridge, very gradually decreasing in height posteriorly and unrecognizable behind cxviii (in worm with 164 segments, mm. 82 of length 105), or cxix (in worm with 162 segments, mm. 122 of length 155). In one worm a short, anterior portion of the typhlosole is slightly thickened, with numerous, small, vertically placed, buttress-like ridges on the lateral faces so that the typhlosole has an appearance of being triangular in cross section. From xxvii to lii (5) on the floor of the gut at the mid-ventral line there is a longitudinally placed groove. The margins of the groove may be rather conspicuously raised to form two, longitudinal ridges. Calciferous glands, cæca and supra-intestinal glands are lacking.

The dorsal blood vessel (single) extends anteriorly to and apparently into the pharyngeal bulb. A supra-œsophageal trunk is probably present in x–xiii and adherent to the gut, but is usually empty, in one specimen distended with blood only in xiii where it bifurcates posteriorly, each branch passing laterally to a heart. Extra-œsophageal trunks are formed anteriorly (in iv or v?) by the union of vessels from the pharyngeal bulb and a vessel on the parietes that is parallel but slightly lateral to the nerve cord. Posteriorly in xi or xii each extra-œsophageal turns mesially onto ventral face of the gut and disappears close to the median line. The ventral trunk bifurcates at the anterior margin of the subpharyngeal ganglia. Lateroparietal trunks were not found, and a subneural trunk is lacking (5). Hearts of x–xiii bifurcate dorsally, one branch passing to the dorsal vessel and the other to the supra-œsophageal. Commissures of ix open only into the dorsal trunk. Commissures from the dorsal trunk are present in vi–viii, but have not been traced to the ventral trunk, commissures and hearts of ix–xiii passing into the ventral trunk. The last pair of hearts is in xiii (7). No hearts or commissures have been found in xiv (7).

Nephridia are transversely placed loops in the anterior portions of the segments, extending from *a* to or nearly to *d*. Nephrostomes are small and rounded, close to the ventral parietes in region of *b*. Nephridia are present in xviii though crowded between the loops of the prostate.

Male funnels are present in x and xi, in clitellate specimens with slight or fairly marked spermatozoal iridescence. Seminal vesicles are paired in xi and xii, vertically placed, on the posterior faces of 10/11 and 11/12 reaching upwards to or nearly to the dorsal vessel, but ventrally not to the parietes. In x and xi beneath the gut there is compacted coagulum in clitellate worms, but testis sacs have not been found in either segment, nor seminal vesicles in x. Prostates are confined to xviii, but bulge 17/18 anteriorly and 18/19 posteriorly. The prostatic duct is 1½–2 mm. long, with muscular sheen, slightly thickened ectally, curved once entally to produce a J-shape.

The deferent ducts of a side pass simultaneously into an ectal portion of the prostate gland, definitely ental to the duct.

Two penisetal follicles are present on each side, bound together entally, diverging ectally, the lateral follicle passing into the parietes on the posterior face of the prostatic duct. Each follicle contains one seta. There are no marked differences between setæ of *a* and *b* follicles. The setal shaft is slightly arced, or may be nearly straight, except for slight curves near ectal and ental ends, both curves on the same side of the shaft, the tip rounded. Ornamentation is of somewhat irregular, transversely placed rows of fine spines, an occasional spine slightly widened entally and triangular. There are no enlarged spines or teeth towards the ectal end of the ornamented region.

Measurements of Penial Setae

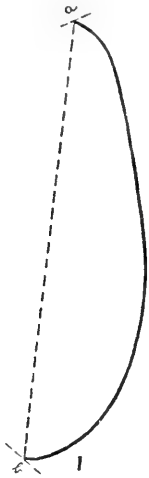
| *Seta* | *Length* | *Thickness* | *Extent of ornamentation* |
|---|---|---|---|
| *a* | 1.23 | 0.06 | 0.35 |
| *b* | 1.22 | 0.04 | 0.31 |
| *a* | 1.15 | 0.05 | 0.32 |
| *b* | 1.15 | 0.05 | 0.38 |
| *a* | 1.14 | 0.04 | 0.30 |
| *b* | 1.15 | 0.045 | 0.35 |
| *a* | 1.12 | 0.042 | 0.28 |
| *b* | 1.15 | 0.05 | 0.27 |

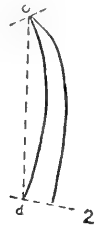
Length is measured along line ab in fig. 1.
Thickness is measured at region of greatest width at or near base.
Extent of ornamentation is measured along line cd in the figure.
The first four setæ are from one specimen, the other four from another worm.

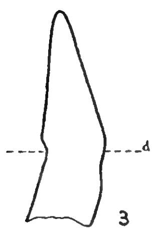
Spermathecæ are large, reaching dorsally into contact with the parietes, all four spermathecæ of the thecal worm of about the same size. The duct is not slender, shorter than, and clearly marked off from the ampulla, with one slight bend, abruptly narrowed within the parietes. In the narrowed parietal portion the lumen is small and almost circular in section, this passage opening into the wider, ental portion of the lumen through a small papilla, which forms nearly all of the floor of an ental chamber. In this chamber the lumen is irregularly elliptical to almost circular in cross section.

The longitudinal musculature is uninterrupted over the sites of genital markings which are areas of epidermal thickening.

*Remarks.* Nephropores are occasionally visible on clitellar segments, on *c* or *d*, but have not been recognized with certainty on postclitellar segments. As all specimens are more or less strongly contracted a different method of killing and fixing is probably re-







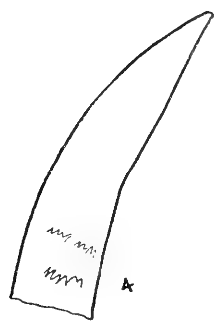


Fig. 1. Isolated penial seta of *Plutellus papillifer* (Eisen). Length is measured along dotted line *ab*.

Fig. 2. Ectal portion of penial seta of same. Extent of ornamentation is measured along dotted line *cd*, *d* indicating the level where ornamentation ends. The ornamentation begins at various levels from just behind the spear-head-shaped portion.

Fig. 3. Tip of a penial seta of same. × *ca.* 325. Ornamentation begins at *d*.

Fig. 4. Tip of a penial seta of same. × *ca.* 325. Dotted line indicates level where ornamentation begins. All figures are camera lucida sketches.

quired to provide satisfactory material for study of the nephropores and dorsal pores.

Spermathecal pores are lacking on six specimens, a grey spot recognizable in the epidermis at the site of each spermathecal pore, but even with best optical conditions no perforation visible. In each of the six specimens, on the coelomic face of the parietes over approximate site of each spermathecal pore, there is a tiny, rounded body, presumably the rudiment of a spermatheca, the rudiments of about the same size in juvenile and clitellate worms. An athecal condition found more or less frequently in certain species of Oriental earthworms is thought to be due to inhibition of development, resulting from activities of parasites in juvenile stages prior to the period when the spermathecæ begin to form, while complete or incomplete batteries of deformed or rudimentary spermathecæ, less frequently found, are the result of parasitic activity at a later stage. Some such parasitic activity may have been responsible for the rudimentary condition of the spermathecæ in the specimens of *papillifer* as iridescence on the male funnel is produced by the presence of ripe spermatozoa, thus indicating a stage of maturity at which full development of all sex organs might be expected. No parasites have been observed in the California worms, and the masses of gregarines so often associated with inhibition or abnormal development of spermathecæ in the Oriental worms are absent. There is of course another possibility, that spermathecæ develop very rapidly after other sexual organs have matured.

On the anterior faces of 6/7–9/10, on each side and just median to the vascular commissure, there is a fairly conspicuous but thin, flat band of white tissue with frayed margins, the band curved into an arc like that of the commissure.

Two subspecies, *ornatus* and *papillifer*, were recognized by Eisen, who was unable to find internal differences between worms with paired and unpaired genital papillæ. Michælsen after examination of penial setæ of specimens, obtained from Eisen, of *ornatus* and *papillifer* raised the latter to specific status, but omitted reference to other internal structures. As there are contradictions in Eisen's account of the internal anatomy of *marmoratus* there may be internal differences of taxonomic importance—note for instance (1894, p. 41) "Dorsal and ventral vessels connected by five pairs of hearts in xiv to x.", and (p. 53) "Three pair of stout, oblong, thrice-contracted and sac-like hearts connect the ventral and dorsal vessels in x, xi, and xii.". Neither of these characterizations is applicable to the forms described above, which may indicate failure to recognize a third species, though presence of hearts in xiv would be most unusual for a Megascolecid.

Absence of large teeth near ectal end of the penial shaft seems to be characteristic and may provide further evidence, in addition to differences in genital markings,[1] for specific distinctness from *marmoratus* as well as *collinus*. This latter species is dubious and, aside from the difference in penial setæ, cannot be distinguished at present from *papillifer*. *P. sierræ* Michælsen 1921 (erected on two juvenile and one aclitellate specimens) can be distinguished at present from

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[1] Eisen (1894, p. 53 and p. 55) mentions having had one specimen of *marmoratus* with unpaired, median genital markings and one specimen of *papillifer* with paired markings. As Eisen differentiated *marmoratus* and *papillifer* from each other only by the paired or unpaired condition of the genital markings, the sole criterion for identification of these exceptional specimens was geographic.

*papillifer* only by the absence of genital markings,—the "quere ventralmediane Pubertätspolster", probably of no taxonomic importance as a similar appearance characterizes one of Herre's specimens. Absence of genital markings may not be a valid criterion for specific status, as an occasional specimen of a species with genital markings may fail to develop the markings. Dimensions and ornamentation of penial setæ of *P. sierræ* are similar to those of setæ from Herre's specimens of *papillifer*, while penial setæ of Michælsen's specimen of *papillifer* are longer, slenderer, and (judging from the figure) with a distinctly different type of ornamentation. In absence however of information as to the method of measurement of length little importance can be attributed at present to size differences.

Because of the uncertainty with regard to several characteristics that may be of taxonomic value in connection with the problem of differentiating Californian species it is impossible to give a definitive diagnosis of *papillifer*, or even to be sure that *papillifer* is the correct name for the specimens described above. The subjoined diagnosis, based on Herre's specimens, can be regarded only as tentative. To fix the species, worms from one of Eisen's original *papillifer* localities must be adequately characterized and designated as a Neotype and Neoparatypes. Such specimens should be preserved in the best possible condition, and deposited in some museum or museums where they will be available for study.

Californian species of *Plutellus* as a group are distinguished from Guatemalan and Oregon species by spermathecal characteristics, from the Guatemalan species by the quadrithecal condition, and from the Oregon species by the adiverticulate spermathecæ.

*Diagnosis.* Quadrithecal; spermathecal pores on or close to sites of 7/8–8/9, on *b*, on or close to centres of transversely placed porophores. Male pores minute, longitudinally placed slits on *b*, each pore together with apertures of penisetal follicles on an indistinctly demarcated, transverse porophore with convex surface; apertures of penisetal follicles dislocated into *ab*, apertures of *b* follicles closer to male pores than to those of *a* follicles. Genital markings unpaired, median, transversely placed areas of epidermal thickening, in middle half of *aa*, on 9/10–10/11, 14/15, and 19/20–20/21; a transversely placed, broadly crescent-shaped marking immediately anterior and posterior to each male porophore. Female pores paired, on or close to *a*. First dorsal pore on 18/19–19/20. Clitellum saddle-shaped, on xiii–xviii and ventrally to *b*. Nephropores on *c* or *d* (only?). Setæ: *ab ca.* = ½*bc*, *bc ca.* = *aa* slightly < *cd*, *dd* < ½C. Prostomium epilobous. Unpigmented. Length 85–155 mm. Diameter 4–6 mm.

Gizzard in v. Intestine begins in xvii. Typhlosole lamelliform, small, in xxvii : : cxviii–cxix. Last hearts in xiii. Holandric; seminal vesicles in xi and xii. Vas deferens passes into ectal portion of prostate gland. Spermathecal duct shorter than the ampulla, lumen in ental chamber opening through an ectal papilla into narrow passage within short, slender, parietal portion. Penial setæ 1.12–1.23 mm. long and 0.042–0.06 mm. thick, shaft slightly arced; ornamentation of transversely placed rows of fine spines, terminating *ca.* 0.27–0.35 mm. from ectal end.

## Family LUMBRICIDAE

### Genus **Allolobophora** Eisen

### **Allolobophora caliginosa** (Savigny) 1826

### f. **trapezoides** (A. Duges)

*Material examined.* Ten clitellate specimens labelled, "In boggy meadow in soil and under dead limbs from pine trees,—one mile east of Cow Creek Ranger Station, Sonora Pass Road, Tuolumne Co., Calif. Sierra Nevada Mts., altitude about 5,800 feet. July 17, 1939. Coll. Ira L. Wiggins."

*Notes.* Setæ *a* and *b* are a trifle more closely paired on xv than on xiv or xvi as a result of median displacement of *b*, or lateral displacement of *a*, or both, and are smaller than on xiv and xv, sigmoid. Ventral Setæ of ix–xi are modified. Ventral setæ of xii–xiv are sigmoid, ornamented near tips with transverse rows of very fine teeth. Ventral setæ of xxx and xxxii are also slightly modified, small.

Seminal vesicles of ix–xi contain small brown discs.

### Genus **Octolasium** Örley

### **Octolasium lacteum** Örley 1881

*Material examined.* One clitellate specimen labelled, "In boggy meadow in soil and under dead limbs from pine trees,—one mile east of Cow Creek Ranger Station, Sonora Pass Road, Tuolumne Co., Calif. Sierra Nevada Mts., altitude about 5,800 feet. July 17, 1939. Coll. Ira L. Wiggins."

The *b* setæ of xv are displaced mesially. Tubercles are present in *ab* on xxii. All nephropores, when recognizable, are close to the *b* line.

The typhlosole begins in the region of xix or xx and ends in xc (specimen of 111 segments).

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# NOTES ON A COLLECTION OF REPTILES AND AMPHIBIANS FROM GUATEMALA*

## II

## LIZARDS

BY

JOSEPH R. SLEVIN
*Curator, Department of Herpetology*
*California Academy of Sciences*

In a previous paper[1] the author has discussed the snakes taken during the spring of 1924 and of 1926, enumerating the various localities worked along the trans-Guatemalan railway. It is now proposed to treat of the lizards, and the reader is referred to the above mentioned paper for the list and descriptions of the localities visited.

My thanks are due Dr. Thomas Barbour who identified that very difficult group, the anoles, and to Drs. Hobart Smith and Charles E. Burt who worked on the lizards of the genera *Sceloporus* and *Cnemidophorus* respectively.

The material on which the present paper is based includes eleven genera, and twenty-two species; 2,263 specimens in all.

The anoles appeared to be the most abundant of the Guatemalan lizards and shared with those of the genera *Sceloporus* and *Ameiva* the distinction of having the greatest range in altitude. While both of these genera were found at sea-level in the vicinity of Champerico, *Ameiva* extended its range to an elevation of 5000 feet on the slopes of the Volcan Agua, and *Sceloporus* to 10,000 feet at Santa Elena. The remaining genera, with the exception of *Gerrhonotus*, a strictly highland lizard, were taken in a belt from sea-level to an elevation 2,000 feet.

*Printed from the John W. Hendrie Publication Endowment

[1]Proc. Calif. Acad. Sci., 4th Ser., Vol. XXIII, No. 26, pp. 393-414, Dec. 29, 1939

### **Anolis biporcatus** Wiegmann

This species is represented by one hundred and twenty-two specimens; 66, Nos. 67050-67115, from Quirigua; six, Nos. 67116, 67118, 67119, 67122, 67168 and 67169, from Mazatenango; 49, Nos. 67117, 67120, 67121, 67123, 67125-67167, 67170 and 67171, from Volcan Zunil, and a single specimen, No. 67124, from Champerico.

It was found commonly on the banana trees and more sparingly on vines entwined about wire fences. Like all the lizards of this genus it proved to be very active and when thoroughly frightened was difficult to catch, as it made leaps of from two to three feet about the dense undergrowth. It appeared to be a characteristic habit of the anoles that on leaping from one limb to another and alighting head upwards the lizard invariably turned about and faced head down.

In life the ground color of *Anolis biporcatus* is golden-brown, covered with dark markings or reticulations, and may or may not have a wide vertebral stripe. No. 67053 in the above series had a wide dorsal stripe of deep orange, bordered with a very narrow stripe of lemon-yellow and extending from the back of the head on to the base of the tail, where it tapered to a point. The dewlap is blood-orange.

### **Anolis cupreus** Hallowell

An abundant species on the banana trees planted to shade the cafetals on Finca El Cipres, where four hundred and three specimens, Nos. 67599-68001, were collected. Eight specimens, Nos. 67591-67598, were taken on banana trees at Quirigua. Although a small species it was easily found as it frequented the trunks of banana trees and was more or less in the open, confining itself to the trunks of the trees or to dead leaves hanging loosely about the trunks.

In life the ground color is light brown, occasionally with darker markings and a pale yellow vertebral stripe. The dewlap is rather small and a uniform pale yellow.

### **Anolis godmani** Boulenger

An inhabitant of the coffee and banana belts, this species was not found in such numbers as some of the others, only fifty-eight specimens being taken as follows: 48, Nos. 67172-67219, from Quirigua; nine, Nos. 67221-67229, from Volcan Zunil, and a single specimen, No. 67220, from Mazatenango. These lizards were more partial to the vines entwining fences than to the banana trees, and were not disposed to show themselves in the open. The species is no doubt just as abundant as those taken in larger series, but, owing to its small size and more secretive habits, is not so readily seen in the green foliage and heavy undergrowth.

In life the ground color is greenish, with occasional dorsal spots of brown and a dark band between the eyes. The dewlap is light orange. Alcoholic specimens show none of the delicate green ground color.

### **Anolis humilis** Peters

Although thirteen days were spent at Quirigua and one hundred and thirty-one anoles were collected, only two specimens, Nos. 68217-68218, of this species were found. Both were taken on banana trees on the Nahua Ranch of the United Fruit Company. The dorsal coloration is uniform brown. The dewlap is quite small and purplish in color.

### **Anolis petersii** Bocourt

During an extended stay at Finca El Cipres this species was not encountered, but my host, Señor Juan Posadas, presented me with three specimens; two, Nos. 68214-68215, from Mazatenango, and one, No. 68216, from his plantation on the slopes of Volcan Zunil. Possibly the reason for not finding this species was seasonal as the specimen from Volcan Zunil was taken in the month of December, a season in which I did not collect.

### **Anolis sallaei** Günther

*Anolis sallaei* was found to be a common species. It inhabits dense foliage and were it not for its brilliantly colored dewlap, its long tail and its unusual activity, it might not be easily detected. It likes the warmth of the sun, and when seen perched upon a leaf or twig with its large orange dewlap, centered with a spot of indigo-blue, extended to full size it becomes very conspicuous against a background of light green. A series of two hundred and nine specimens are from the following localities: Nos. 68002-68017, Quirigua; Nos. 68038-68041, Champerico; Nos. 68199-68208, Los Patos River; Nos. 68198, 68022-68032, Mazatenango; Nos. 68018-68021, 68033, 68036-68037, 68042-68197, 68209-68213, Volcan Zunil.

In life this species is one of the most beautifully colored of the Guatemalan anoles being a rich, clear, golden-yellow and occasionally having a heavy, lemon colored vertebral stripe. As mentioned above the dewlap is orange, with a central spot of indigo-blue.

### **Anolis uniformis** Cope

This species appeared to be confined to the highlands and was particularly abundant at Chichivac, above Tecpan. A single patch of tall grass situated on an open hillside was the source of a series of three hundred and fifty-three specimens, Nos. 67238-67590. Upon pulling apart the clumps of grass the lizards were found clinging to the blades a foot or two above the ground. A single specimen, No. 67237, was taken at an elevation of 6,800 feet in a small clump of weeds in a cornfield at the edge of the rain forest above San Antonio. Seven specimens, Nos. 67230-67236, were taken in similar situations on the slopes of the Volcan Agua.

In life the ground color is brownish, and a broad vertebral band of yellow, with a narrow black border, is occasionally present. The dewlap is a rich orange color.

### **Basiliscus vittatus** Wiegmann

This proved to be a common and widely distributed species, a total of ninety-one being taken as follows: Nos. 69185-69194, San Antonio; Nos. 69195-69227, Quirigua; Nos. 69228-69247, 69258-69262, 69274-69275, Volcan Zunil; Nos. 69248-69256, Mazatenango; No. 69257, Champerico; Nos. 69263-69273, Los Patos River.

With the exception of those taken at San Antonio, all were found on the banks of streams or in very close proximity to water, the San Antonio specimens being taken in trees bordering a road, the nearest water being a hundred yards or more away. An extremely wary lizard it would keep in the heavy growth of vines bordering the streams, and at the slightest disturbance it would leap into the water, or seek the denser foliage where it would be lost to view. The present series shows no variation in color, the brownish-olive ground color, with a yellow lateral stripe, being constant. Its native name is *Cotate.*

### **Iguana iguana rhinolopha** (Wiegmann)

This species was found more commonly in the rain forest areas, though it also inhabits the arid country about Progreso. A great many individuals were seen but on account of its large size only a few were taken. The series is as follows: No. 69312, Progreso; Nos. 69313-69315, Volcan Zunil; No. 69311, Quirigua. The latter was found stretched at full length on the top of a high hedge.

Although brilliantly marked with white and black bands on a ground color of light green it is not so easily detected in its native habitat, the heavy foliage and high trees of the tropical forests.

### **Ctenosaura palearis** Stejneger

A common species about Progreso, where it was found high up in the tall trees. A series of fourteen specimens, Nos. 69297-69310, was taken. Juveniles, in life, are bright green, the black bars and grayish sides of the adults are not evident until the lizard attains a considerable size.

### **Ctenosaura similis** (Gray)

This species was found to be fairly abundant on both sides of the plateau, but on account of its large size the series had to be limited. Twenty-one specimens were taken as follows: Nos. 69276-69286, Progreso; Nos. 69287-69290, Los Patos River; Nos. 69291-69296, Champerico. At Progreso and Champerico they were found in trees and at Los Patos River in the tiled roofs of houses. Young individuals are bright green, as in the former species, changing to the characteristic greenish-gray later in life, the tail then becomes ringed and the body barred with black.

### **Sceloporus acanthinus** Bocourt

Found only in clearings in the rain-forest, and is represented by five specimens as follows: Nos. 68389-68390, Mazatenango; Nos. 71403-71404, Volcan Zunil; No. 68931, Los Patos River. The two specimens from Mazatenango were taken in dense rain-forest country and were found some fifteen feet above the ground running about the trunk of a giant Ceiba tree. The one from Los Patos River was taken on a fence post in a clearing of virgin jungle.

The males of this species, in life, are metallic bluish-green on the dorsal surface. The undersurface of the body and throat is blue, that of the hind limbs and tail being yellowish, with a tinge of green. A black collar completely encircles the neck. The females do not attain the brilliancy of the adult males, having a dorsal ground color of brown. A collar is present, but does not meet on the throat. The undersurfaces are yellowish, the throat being clouded with dark gray. The femoral pores in the five specimens range from twelve to fifteen.

### **Sceloporus formosus smaragdinus** Bocourt

A common species in the highlands where one hundred and twenty-seven specimens were collected as follows: 17, Nos. 68219-68235, Volcan Agua; 55, Nos. 68236-68290, San Antonio; 55, Nos. 68291-68345, five miles north of Tecpan; two, Nos. 68392-68393, Santa Elena. At San Antonio and the Volcan Agua it was found on rock fences which enclosed large stretches of open country, while about the vicinity north of Tecpan it was equally divided between rocky situations and solitary trees close to heavily wooded areas.

A male, No. 68225, from Volcan Agua, was colored in life as follows: Dorsal surface and upper surface of limbs light green; tail bottle-green above to lighter green on the sides and undersurface; top of head brownish; a black shoulder patch; a black collar extending across the throat; throat light blue; undersurface between limbs light blue, with two longitudinal bands of black separated by a line of greenish-yellow; undersurface of tail yellowish.

The femoral pores in 212 thighs are as follows:

| *Pores* | *Thighs* |
|---|---|
| 11 | 2 |
| 12 | 9 |
| 13 | 25 |
| 14 | 60 |
| 15 | 73 |
| 16 | 26 |
| 17 | 17 |

### **Sceloporus siniferus** Cope

Found only on the seacoast, where eighteen specimens, Nos. 68358-68375, were collected along an open road cut through what was formerly heavy rain forest in the vicinity of Champerico. It appeared to be strictly terrestrial in its habits, never getting farther off the ground than the top of a rock or small boulder.

The ground color, like in its near relative *S. squamosus*, is reddish-brown, a lateral stripe of yellow one to one and one-half scales wide extending from the back of the head to the base of the tail. A pronounced black spot over the shoulder is usually present. The area between the lateral lines may be clear or have a series of black spots on each side. The sides may be either with or without black spots. The undersurfaces are grayish, the throat sometimes being clouded with dark gray and having a series of longitudinal white stripes.

The femoral pores in thirty-five thighs vary from four to six; being four 12 times, five 18 times, and six five times.

### **Sceloporus squamosus** Bocourt

A species found both in the highland country, at the base of the Volcan Agua, and in the desert area about Progreso. It was not common in either locality, only eleven specimens, Nos. 68346-68356, being taken at the former locality and two, Nos. 68357, 68376, at the latter. At the Volcan Agua it was seen in corn fields on the lower slopes of the mountain, and at Progreso along the side of a trail leading from open country to a wooded and rocky area.

The ground color is a dark reddish-brown, with a whitish lateral line one scale in width extending from the back of the head to the base of the tail. A series of black spots extends down the back, the posterior borders of which have a light edge. The sides are spotted with white and the undersurfaces are grayish.

The femoral pores in twenty-six thighs range from five to seven; being five 9 times, six 14 times, and seven 3 times.

### **Sceloporus variabilis variabilis** Wiegmann

This species was found only at Progreso, where a small series, Nos. 68377-68388, was taken. It was confined to rocky situations along trails and roads in the higher portions of the desert-like areas. There is apparently no difference in coloration from those collected farther to the north in the states of Oaxaca and Vera Cruz, Mexico.

A male, in life, showed a dorsal ground color of light brown, with scattered blue and yellow spots and a dorsolateral stripe of light brown. The upper surface of the limbs was blackish and of the tail light gray to pink. The belly had two large patches of pink, edged with blue, and separated by a median line of white. Two black shoulder patches were bordered in front by a line of light yellow.

Femoral pores in the above series vary from six to thirteen; being six two times, eight two times, nine four times, ten seven times, eleven seven times, twelve two times, and thirteen once.

### **Gerrhonotus moreletii** Bocourt

Strictly confined to the highlands this species was found to be common at Chichivac, where eighty specimens, Nos. 68394-68473, were taken in the surrounding forest that had been cut over for timber. Their habitat was under debris on the forest floor and under the loose bark of dead trees and old stumps. Five specimens, Nos. 68474-68478, were taken at Santa Elena under similiar conditions. An examination of eighty-four specimens shows a contact between the frontonasal and frontal, a partial separation in three, and a complete separation in one. No. 68419 shows a complete separation. No. 68402 has the prefrontal on the left side forming a narrow suture, and No. 68436 a practically complete separation, the prefrontals terminating in a point which contacts the frontonasal. Scale rows are eighteen in 71 specimens and twenty in 14.

The dorsal coloration is dark brown, spotted with black. The undersurfaces are greenish-white. Juveniles show darker sides and less spotting on the dorsal surface.

### **Lepidophyma flavomaculatum flavomaculatum** Duméril

This species is strictly confined to the rain-forest. Twenty-eight specimens were taken as follows: Four, Nos. 68479-68482, from Quirigua; three, Nos. 68483, 68505, 68506, from Volcan Zunil; and twenty-one, Nos. 68484-68504, from Mazatenango.

With the exception of a single specimen (No. 68482) found in a crack between two stones, part of the wall of a large ruin near Quirigua, all were found under debris on the forest floor or in decaying logs. The old logs sought by these lizards were on the floor of the rain forest, thoroughly soaked from the heavy rains and covered with vines and moss. The interiors were honeycombed with termite tunnels, and an examination of the stomachs of the lizards showed that termites formed their principal food.

In life the ground color is a rich brown, the dorsal surface being covered with yellowish spots. The undersurfaces are whitish.

### **Ameiva undulata parva** Barbour and Noble

A common lizard and found abundantly from the low country to the higher elevations at the base of the Volcan Agua, but very rare in the drier desert area about Progreso. In the coffee districts it was usually found running about the cafetals in search of food and in the wet, humid belt about Quirigua it was a conspicuous lizard amongst the banana trees. A total of two hundred and eighty-eight specimens was taken as follows: Nos. 68629-68662, Volcan Agua; Nos. 68663-68733, San Antonio; Nos. 68734-68765, Quirigua; Nos. 68766-68844, Volcan Zunil; Nos. 68845-68865, Mazatenango; Nos. 68866-68867, Champerico; Nos. 68868-68914, Los Patos River; Nos. 68915-68916, Progreso.

Specimen No. 68671, from San Antonio, was colored, in life, as follows: A wide brownish dorsal band extended from the back of the head to the base of the tail, with black bars between limbs broken on median line; top of tail light brown, with black spots at base; top of head brown; top of limbs brown, mottled with black; sides of head and the gular region lemon-yellow; sides between limbs sky-blue; belly, undersurface of hind limbs and tail sky-blue; undersurface of front limbs yellowish.

The color of the gular region in this species varies and may be lemon-yellow, orange, or brick-red.

The femoral pores in 572 thighs vary from eleven to twenty-one as follows:

| *Pores* | *Thighs* |
|---|---|
| 11 | 2 |
| 12 | 6 |
| 13 | 30 |
| 14 | 68 |
| 15 | 105 |
| 16 | 119 |
| 17 | 101 |
| 18 | 76 |
| 19 | 42 |
| 20 | 21 |
| 21 | 2 |

### **Cnemidophorus deppii deppii** (Weigmann)

An abundant species at Progreso, where one hundred and thirteen specimens, Nos. 68917-69029, were taken. All were found in cactus fences along open roads. The entire series, with the exception of fourteen individuals which have the dorsal lines fused so as to form a single wide one, have ten longitudinal lines. The supraoculars are three in all but six specimens, two of which have the front plate divided, one the left middle plate, one the right middle plate, and one the middle plate on both sides.

The dorsal coloration, in life, is black or greenish, occasionally with a reddish tinge between the first two lateral lines. The undersurface of the tail and hind limbs is yellowish. In males the belly and throat are bluish-black, the females being yellowish, with a slight green tinge.

Femoral pores in 223 thighs vary from 16 to 22 as follows:

| *Pores* | *Thighs* |
|---|---|
| 16 | 7 |
| 17 | 42 |
| 18 | 64 |
| 19 | 62 |
| 20 | 34 |
| 21 | 13 |
| 22 | 1 |

### **Cnemidophorus sexlineatus gularis** (Baird and Girard)

The most abundant lizard in the vicinity of Progreso, where it was found in common with *C. deppii deppii*. A series of one hundred and fifty-five specimens, Nos. 69030-69184, was taken. These Guatemalan specimens of *C. s. gularis* are uniformly large and rival *C. maximus* in size. Although these lizards were found not to be particularly shy there was always a cactus fence in sight in which to take cover, and nothing could give them better protection.

The color pattern in the above series is uniform throughout. Stripes are absent and the dorsal coloration is grayish-brown, with numerous small white spots, which are also present on the upper surface of the limbs. The undersurfaces are greenish-white, the belly being suffused with indigo-blue.

In one hundred and fifty-four specimens the femoral pores vary from 20 to 27 as follows:

| *Pores* | *Thighs* |
|---|---|
| 20 | 3 |
| 21 | 26 |
| 22 | 85 |
| 23 | 78 |
| 24 | 75 |
| 25 | 35 |
| 26 | 5 |
| 27 | 1 |

### **Mabuia agilis** (Raddi)

This species was found in both the rain forest and the drier desert areas, and was taken from sea-level at Champerico to 2,000 feet at Volcan Zunil. In the lowlands at Champerico and Los

Patos River it was seen along wire fences in more or less open country, and in the rain-forest area in old stumps and under stones. It was not common, and only twenty-one specimens were collected, as follows: Nos. 68608-68609, Progreso; Nos. 68610-68611, Champerico; Nos. 68612-68613, Mazatenango; Nos. 68614-68616, Volcan Zunil; Nos. 68617-68628, Los Patos River.

In life the dorsal area is metallic bronze in color. A wide lateral band of dark brown extends from the snout to the groin, and is bordered above by a wide grayish line and below by a thin white one. The undersurfaces are whitish.

### **Leiolopisma assatum assatum** (Cope)

This skink proved to be one of the most abundant lizards at Finca El Cipres, where one hundred and one specimens, Nos. 68507-68607, were collected. All were dug out of piles of earth in the cafetals. None was ever seen in the open.

In life the dorsal surface is brownish, the scales with dark brown centers, tending to form longitudinal lines. A black band extends along the side of the head and neck to the shoulder. The labials are whitish, spotted with brown. The undersurfaces are whitish.

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# NOTES ON A COLLECTION OF REPTILES FROM BOQUETE, PANAMA, WITH THE DESCRIPTION OF A NEW SPECIES OF HYDROMORPHUS*

BY

JOSEPH R. SLEVIN

*Curator, Department of Herpetology*
*California Academy of Sciences*

Through the kindness of Mr. and Mrs. Robert Terry, of Boquete, Chiriqui, Panama, the writer was enabled to spend the summer of 1939 as their guest and enjoyed their hospitality and assistance for a period of four months in that most interesting region. The actual time spent in the field was from May 11th to September 15th.

The rainy season of 1939 proved to be an extremely dry one. This no doubt modified conditions considerably, but apparently did not greatly affect reptile collecting, although it may have accounted for the scarcity of some of the species of lizards. However it must have had a considerable influence on animal life in general. Up to May 17th there had been only one light shower, and on the 22nd the first, real tropical downpour occurred. These rains did not continue, and up to the middle of August the country was badly in need of rain. The beginning of September saw a change, but even then the real tropical rains were not in evidence.

The collection of snakes considered in the present paper includes 20 genera, 21 species, and 220 specimens; the lizards 7 genera, 11 species, and 447 specimens. Of the snakes *Hydromorphus dunni* is a new species, *Ninia psephota* new to Panama, and *Spilotes p. pullatus*, *Sibon sibon* and *Leptophis o. occidentalis* new records for Boquete, and altitude records for western Panama. Of the lizards

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*Norops auratus* is an altitude record for western Panama and new record for Boquete.

My thanks are due Dr. Emmett R. Dunn for assistance in making identifications, and for much information from his critical notes concerning Panamanian reptiles, and to Plinio Ruiz, my invaluable native companion, to whom I am indebted for much able field assistance.

## LIZARDS

### **Anolis copei** Bocourt

A series of 54 males (C.A.S. Nos. 79036-79089) and 68 females (C.A.S. Nos. 79090-79157) showed this to be, next to *Anolis polylepis*, the most abundant anole met with. It was generally found in the larger and higher trees, but occasionally on fence posts, and once or twice on the ground. While most frequently seen on the tree trunks it was often discovered on fairly high limbs, crouching down as if to avoid detection. In living specimens the ground color was usually uniform light green, but variations occasionally occurred. No. 79090, a female, was uniform light green, shaded with black; belly greenish-white. The posterior two-thirds of the tail was black. No. 79091, a female, had a ground color of light green, with occasional black blotches. The top of the head was black. No. 79036, a male, was light green, with heavy black cross-bars both on body and limbs; top of head uniform black; belly whitish, with longitudinal black lines. The rather large dewlap of the males had a ground color of orange, with rows of bluish scales. The entire series of males, in life, had a dewlap as described above, while in females the ground color was light blue, with rows of black scales. Color changes took place so quickly that a bright green lizard shot from the limb of a tree would be reddish-brown on striking the ground.

### **Anolis intermedius** Peters

This species was found rather sparingly in the vicinity of Boquete. Its habitat seemed to be strictly confined to the coffee trees, and the entire series of eight specimens (C.A.S. Nos. 79367-79374) was taken from the older trees on which the bark was mottled silver-gray and brown. The lizard matched this background closely in color and was difficult to detect. The dewlap, in life, is a rich blood-orange.

### **Anolis microtus** Cope

A single juvenile specimen (C.A.S. No. 79598) was shot off the side of a log cabin in a partly grown-over clearing on the north slope of the Volcan Chiriqui, at an approximate elevation of 7,000 feet. In life the ground color is grayish, the body and tail with heavy black cross-bands, which completely encircle the latter; top of limbs cross-barred. A white line extends from under the front of the eye to the shoulder, where it broadens into a patch; undersurface whitish, the chin with dark grayish spots along the sides. The dewlap is whitish, with straw-colored rows of scales.

### **Anolis pachypus** Cope

A stop of three days in the rain forest on the north slope of the Volcan Chiriqui at an approximate elevation of 7,000 feet resulted in the finding of only two specimens of this species (C.A.S. Nos. 79596-79597) a male and a female. Both were found while cutting the foliage from around the tops of dead stumps. In life the ground color is greenish, with faint traces of black cross-bars on limbs and tail; sides of head black; undersurface whitish. The throat of the female is prominently spotted with black, while the markings of the male are more obscure. The black coloring on the head of the male extends below the lower labials, giving the throat a black border. Two large black patches back of the fore limbs of the female are absent in the male. The dewlap of the male is a rich blood-red, with straw-colored rows of scales. The base of the tail is greatly enlarged.

### **Anolis polylepis** Peters

This was the most abundant lizard about Boquete, where a series of 209 specimens (C.A.S. Nos. 79158-79366) was taken. One specimen (C.A.S. No. 79595) was collected on the south slope of the Volcan Chiriqui at an approximate elevation of 6,500 feet. No habitat preferences were shown, it being found commonly on fence posts, coffee trees, and foliage in general. In life the ground color is bronze, occasionally with a few black dorsal spots, the females sometimes having a vertebral stripe; undersurface whitish. The dewlap is orange. The vertebral series of enlarged scales varies in size, but is usually quite prominent, being obscure in only three or four individuals of the entire series.

### **Norops auratus** Daudin

Found rather sparingly on a plateau above the floor of the Caldera Valley at an elevation of approximately 4,000 feet. Nine specimens (C.A.S. Nos. 79375-79383) were taken in the region south of Boquete. It is apparently a terrestrial species as it was found only on the ground sunning itself on the tops of small boulders. The dorsal coloring, in life, is bronze. A dark band extends along the sides of the body. The undersurface is yellowish and the dewlap dark blue.

### **Basiliscus basiliscus** (Linnaeus)

A common species along the Caldera River, where eight males (C.A.S. Nos. 79388-79395), six females (C.A.S. Nos. 79396-79401) and four juveniles (C.A.S. Nos. 79384-79387) were taken. These rather striking lizards were usually found in rock walls close to the river bank, or on boulders in the river. Their extreme shyness is no doubt due to the fact that the natives are continually shooting at them with slingshots, an effective weapon in the hands of any Panamanian boy.

### **Sceloporus formosus malachiticus** Cope

This lizard was not found in the Caldera Valley proper, and apparently was confined to an elevation some 800 to 1,000 feet higher in the mountainous areas, where it was fairly common in certain parts, forty specimens (C.A.S. Nos. 79402-79431) having been taken. It was usually found on tree trunks, fallen logs, fences, and rocky situations along the mountain trails. Males have the characteristic metallic-green, dorsal coloring and black collar band. Females are much more somber and show considerable black spotting on the dorsal region. Femoral pores in fifteen males vary from 13 to 17, and in ten females from 12 to 17.

### **Gerrhonotus monticola** Cope

Three days were spent from August 10th to 12th inclusive in a locality rarely visited by herpetologists, the crater of the Volcan Chiriqui, the floor of which is estimated to be 10,000 feet above sea-level. Here 22 specimens (C.A.S. Nos. 79599-79620) of this interesting alligator lizard were collected. It is of particular interest on account of the wide difference in the coloration of the sexes. Cope described a female in 1877, and in 1907 Stejneger described a male as *Gerrhonotus alfaroi*. The color description of a living adult male and female given below shows that the sexes probably differ more in coloration than any other species of the genus. The series at hand shows little if any variation in squamation.

Male—Dorsal and lateral surfaces metallic-black, profusely speckled with minute spots of yellow; undersurface of tail and body lemon-yellow spotted with black; throat and chin greenish-blue.

Female—Dorsal and lateral surfaces chestnut-brown, spotted with black; a dorsal line of black extending from the base of the head well down on the tail; a lateral line of black, bordered above by one of yellowish-white, extending along the body and tail; undersurface of body and tail dark salmon without spots; throat and chin greenish-blue.

Alligator lizards were found to be scattered over the entire crater floor. They usually occurred in the patches of dry grass, hiding close down by the roots, but one short interval of sunshine brought them out of hiding, and five specimens were secured in the open, close to cover. Two were found under the ice-cold, wet moss and earth on the north wall of the crater about four feet above the ground. In each case a salamander (*Oedipus subpalmatus*) was found coiled up with the lizard under the same covering. Unfortunately most of the time the crater was covered by clouds, making the temperature cool, and only at short intervals, when the sky cleared and there was some vestige of warmth and direct sunlight, did reptile life become apparent. Spiders were found in countless numbers in the dry grass and no doubt formed the chief food supply of the lizards.

### **Ameiva quadrilineata** (Hallowell)

This species, found only on the floor of the Caldera Valley, was by no means abundant, only eighteen specimens (C.A.S. Nos. 79432-79449) having been taken. Its usual habitat is along trails, roads and fences which have a sufficient growth of underbrush to furnish a safe retreat. The dorsal surface is olive-gray, mottled with black. Two lateral stripes of white bordering a black band are distinct throughout the series. The undersurfaces are uniform greenish-blue.

### **Mabuya mabuya mabuya** (Lacépède)

Seven of these rather secretive skinks (C.A.S. Nos. 79450-79456) were found about old logs and stumps in open pastures. All have four supraoculars and have the supranasals in contact. In two individuals (Nos. 79451-79452) the parietals are not in contact. In Nos. 79451 and 79454 the prefrontals meet in a point, complete separation takes place in the remainder of the series. The dorsal coloration is dark brown, heavily spotted with black; a heavy black lateral band is bordered below by a prominent white line, while above a narrow one may be very obscure or absent. Undersurfaces are whitish.

## SNAKES

### **Constrictor constrictor imperator** (Daudin)

Rare in the vicinity of Boquete only a single specimen, a male (C.A.S. No. 78816) having been taken. Owing to the poor condition and size (six feet three inches) of the snake the head only was preserved for the locality record. Upper labials are 21-22, lower labials 23-24.

### **Ninia maculata** (Peters)

Moderately common under old logs, bark and general debris in the cafetals. The color is somewhat variable. In life the dorsal region may be reddish or grayish, with cross-bands of black. These may either meet or alternate on the vertebral line. The undersurface is whitish, mottled or dotted with square markings of black, and occasionally with a median, rough-edged, black line down the center of the gastrosteges.

All have 19 scale rows, anal single, preoculars $1-1$, postoculars $2-2$, loreal absent, temporals $1+2-1+2$.

Sexes and variations in scale counts are as follows:

| *No.* | *Sex* | *Gastro-steges* | *Uro-steges* | *Supra-labials* | *Infra-labials* |
|---|---|---|---|---|---|
| 78817 | .... | 137 | 58c | 7–7 | 7–7 |
| 78818 | ♀ | 139 | 59c | 7–7 | 7–7 |
| 78819 | ♀ | 146 | 57c | 7–7 | 7–7 |
| 78820 | .... | 145 | 57c | 7–7 | 7–7 |
| 78821 | .... | 141 | 60c | 7–7 | 7–7 |
| 78822 | .... | 140 | 52c | 7–7 | 7–7 |
| 78823 | ♀ | 136 | 52c | 7–7 | 7–7 |
| 78824 | ♀ | 139 | 55c | 7–7 | 8–8 |
| 78825 | ♀ | 141 | 63c | 7–7 | 7–7 |
| 78826 | ♀ | 145 | 53c | 8–7 | 7–7 |
| 78827 | ♀ | 145 | 57c | 8–7 | 7–7 |
| 78828 | ♀ | 146 | 55c | 7–7 | 7–7 |
| 78829 | ♀ | 138 | 61c | 7–7 | 7–7 |
| 78830 | ♀ | 138 | 60c | 7–7 | 7–7 |
| 78831 | ♀ | 143 | 50c | 7–7 | 7–7 |
| 78832 | ♀ | 141 | 53c | 7–8 | 7–7 |
| 78833 | ♂ | 141 | 62c | 7–7 | 7–7 |
| 78834 | ♀ | 137 | 50c | 7–7 | 7–7 |
| 78835 | ♀ | 141 | 54c | 7–7 | 7–7 |
| 78836 | ♂ | 145 | 61c | 7–7 | 7–7 |
| 78837 | ♂ | 141 | 57c | 7–7 | 7–7 |
| 78838 | ♀ | 143 | 55c | 7–7 | 7–7 |
| 78839 | ♀ | 143 | 59c | 7–7 | 7–7 |
| 78840 | ♀ | 145 | 55c | 7–7 | 7–7 |
| 79302 | .... | 142 | 52c | 7–7 | 7–7 |

### **Ninia psephota** (Cope)

A common species under debris in the cafetals, and occasionally found on open trails. It apparently feeds largely on insects as the stomachs of those examined contained a considerable quantity of beetle wingcovers.

In life the dorsal coloration is black; undersurface a tessellated pattern of black and coral-pink. In alcoholic specimens the pink coloration is entirely lost and changes to a light straw color.

In a series of thirty-one specimens all have 17 scale rows, anal single, supralabials 6 – 6, infralabials 6 – 6, preoculars 1 – 1, postoculars 2 – 2, with the exception of No. 78871 in which they are single, loreal absent.

Sexes and variations in scale counts are as follows:

| *No.* | *Sex* | *Gastrosteges* | *Urosteges* | *Temporals* |
|---|---|---|---|---|
| 78841 | ♂ | 147 | 73c | 2+2 – 2+2 |
| 78842 | ♀ | 147 | 64c | 1+2 – 1+2 |
| 78843 | ♂ | 151 | 72c | 1+2 – 1+2 |
| 78844 | ♂ | ... | 71c | 1+2 – 1+2 |
| 78845 | ♂ | 148 | 70c | 1+1 – 1+1 |
| 78846 | ♂ | 148 | 66c | 1+2 – 1+2 |
| 78847 | ♀ | 151 | 64c | 1+1 – 1+1 |
| 78848 | ♀ | 147 | 58c | 1+2 – 1+2 |
| 78849 | ♀ | 150 | 64c | 1+1 – 1+1 |
| 78850 | ♀ | 149 | 65c | 1+1 – 1+1 |
| 78851 | ♂ | 152 | 59+ | 1+1 – 1+2 |
| 78852 | ♀ | 139 | 51c | 1+1 – 1+1 |
| 78853 | ♂ | 150 | 72c | 1+1 – 1+1 |
| 78854 | ♂ | 150 | 67c | 2+2 – 2+2 |
| 78855 | ♀ | 153 | 64c | 1+2 – 1+2 |
| 78856 | ♀ | 146 | 70c | 1+1 – 1+1 |
| 78857 | ♀ | 152 | 62c | 1+2 – 1+2 |
| 78858 | ♀ | 147 | 55c | 1+2 – 1+2 |
| 78859 | ♀ | 148 | 56c | 1+1 – 1+1 |
| 78860 | ♀ | 145 | 63c | 1+2 – 1+2 |
| 78861 | ♀ | 150 | 65c | 1+1 – 1+1 |
| 78862 | ♂ | 153 | 71c | 1+2 – 1+2 |
| 78863 | ♂ | 153 | 63c | 1+1 – 1+1 |
| 78864 | ♀ | 148 | 61c | 1+1 – 1+1 |
| 78865 | ♀ | 147 | 65c | 1+2 – 1+2 |
| 78866 | ♂ | 152 | 64+ | 1+2 – 1+2 |
| 78867 | ♀ | 152 | 63+ | 1+2 – 1+1 |
| 78868 | ♀ | 148 | 64c | 1+1 – 1+1 |
| 78869 | ♀ | ... | 62c | 1+2 – 1+2 |
| 78870 | ♂ | 147 | 67c | 1+1 – 1+1 |
| 78871 | ♂ | 147 | 68c | 1+1 – 1+1 |

### **Dryadophis boddaertii alternatus** (Bocourt)

This was by far the most common species seen in the open about Boquete. It proved to be extremely wary, and was usually found along fences and in rocky situations in the vicinity of heavy cover, into which it disappeared, seldom allowing a close approach. On examining the stomach of a male (No. 78889) it was found to contain a young individual of the same species over fourteen inches in length.

In life the dorsal coloring is light brown, the first, second, fourth and fifth scale rows being of a much lighter shade and forming lateral stripes. The third scale row is light brown, bordered above and below by a narrow black line. Young individuals are dark brown, with whitish cross-bands two or two and a half scales in width; undersurface whitish, the throat being tessellated with black.

All have 17 scale rows, anal divided, preoculars 1–1, postoculars 2–2, loreal 1–1.

Sexes and variations in scale counts are as follows:

| *No.* | *Sex* | *Gastro-steges* | *Uro-steges* | *Supra-labials* | *Infra-labials* | *Temporals* |
|---|---|---|---|---|---|---|
| 78872 | ♀ | 181 | 90+ | 8–9 | 10–10 | 2+2–2+2 |
| 78873 | ♀ | 173 | 50+ | 9–9 | 10–10 | 2+2–2+2 |
| 78874 | ♂ | 176 | 101c | 9–9 | 10–10 | 1+2–2+2 |
| 78875 | ♂ | 172 | 43+ | 8–9 | 8–8 | 1+1–1+2 |
| 78876 | ♂ | 173 | 72+ | 8–9 | 10–10 | 2+2–2+2 |
| 78877 | ♂ | 171 | 100c | 9–9 | 10–10 | 2+2–2+2 |
| 78878 | ♀ | 187 | 100c | 9–9 | 10–10 | 2+2–2+2 |
| 78879 | ♂ | 179 | 107c | 9–9 | 10–10 | 2+2–2+2 |
| 78880 | ♀ | 183 | 102c | 8–9 | 10–9 | 2+2–1+2 |
| 78881 | ♀ | 183 | 100+ | 9–9 | 10–10 | 2+2–2+2 |
| 78882 | ♀ | 182 | 89+ | 9–9 | 11–10 | 2+2–2+2 |
| 78883 | ♀ | 185 | 103+ | 9–9 | 10–10 | 2+2–1+2 |
| 78884 | ♀ | 184 | 95c | 9–9 | 10–10 | 2+2–2+2 |
| 78885 | ♂ | 175 | 91+ | 8–8 | 9–10 | 2+2–2+2 |
| 78886 | ♂ | 174 | 101c | 9–9 | 10–10 | 2+2–2+2 |
| 78887 | ♂ | 176 | 104c | 9–9 | 9–9 | 2+2–2+2 |
| 78888 | ♂ | 175 | 100+ | 9–9 | 10–10 | 2+1–2+2 |
| 78889 | ♂ | 178 | 103c | 9–9 | 10–10 | 2+2–2+2 |
| 78890 | ♀ | 188 | 78+ | 9–9 | 10–10 | 1+2–1+2 |
| 78891 | ♀ | 183 | 96c | 9–9 | 10–10 | 2+2–2+2 |
| 78892 | ♀ | 183 | 104c | 10–9 | 10–10 | 2+2–2+2 |
| 78893 | ♂ | 171 | 105c | 9–9 | 10–10 | 1+2–1+2 |
| 78894 | ♀ | 185 | 74+ | 9–9 | 10–10 | 2+2–1+2 |
| 78895 | ♀ | 188 | 103c | 8–8 | 10–10 | 1+2–1+2 |

### **Dendrophidion paucicarinatus** (Cope)

A rare species apparently confined to the forested country containing clearings for coffee growing. The five specimens taken were found in heavy undergrowth along trails in the mountainous districts above the floor of the Caldera Valley.

In life the dorsal coloration is uniform brown; undersurface of body and tail yellowish, the posterior edge of each gastrostege and urostege with a narrow border of black.

Scale counts are as follows:

| No. | Sex | Scale Rows | Gastro-steges | Uro-steges | Anal | Supra-labials | Infra-labials | Pre-oculars | Post-oculars | Loreal | Temporals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 78896 | ♀ | 15 | 187 | 131c | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 78897 | ♂ | 17 | 184 | 67c | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 78898 | ♀ | 17 | 182 | 45+ | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 78899 | ♀ | 17 | 187 | 129+ | ÷ | 9–9 | 11–11 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |
| 78900 | ♀ | 17 | 182 | 132+ | ÷ | 9–9 | 11–11 | 1–1 | 2–2 | 1–1 | 2+2–2+2 |

## **Spilotes pullatus pullatus** (Linnaeus)

Four specimens were taken along the banks of the Caldera River. No. 79647 was found stretched along a dead limb projecting over the water, and about ten feet above the surface. It was discovered by a native when he observed a bird about to alight upon the limb. The bird suddenly flew off with a loud cry, thus attracting the attention of the native.

A male (C.A.S. No. 79647) was colored in life as follows: dorsal region black, with a few small straw-colored spots; top of head brownish, with black sutures between the plates and a black band across the posterior edge of the parietals, extending over the upper labials; undersurface anteriorly yellowish, with black markings; posteriorly black; undersurface of tail black.

Scale counts are as follows:

| No. | Sex | Scale Rows | Gastro-steges | Uro-steges | Anal | Supra-labials | Infra-labials | Pre-oculars | Post-oculars | Loreal | Temporals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 78901 | ♀ | 16 | 220 | 72+ | 1 | 7–7 | 8–8 | 1–1 | 2–2 | 1–1 | 1–1 |
| 78902 | ♀ | 14 | 221 | 122c | 1 | 6–7 | 8–9 | 1–1 | 2–2 | 1–1 | 1–1 |
| 78903 | ♀ | 16 | 222 | 111+ | 1 | 7–7 | 9–8 | 1–1 | 2–2 | 1–1 | 1–1 |
| 79647 | ♂ | 16 | 228 | 131c | 1 | 7–7 | 9–8 | 1–1 | 2–2 | 1–1 | 1–1 |

### **Drymarchon corais melanurus** (Duméril and Bibron)

Apparently a rare species in the vicinity of Boquete. A large female, the only specimen taken, was found about six feet above ground in a coffee tree as it was about to rob a wren's nest. On being discovered the snake immediately dropped to the ground and made for cover, where it was captured with some difficulty. This specimen (C.A.S. No. 78904) has scales in 17 rows, gastrosteges 210, urosteges 75c, anal single, supralabials 8–8, infralabials 8–8, preoculars 1–1, postoculars 2–2, loreal 1–1, temporals $2+2-2+2$.

### **Chironius carinatus** (Linnaeus)

This species was moderately rare in the pastures and open country on the floor of the Caldera Valley. None was found in the mountainous districts. It was always close to water and would not allow a near approach, showing the speed of a racer when making for cover. When approaching this species in the field the observer is at once attracted by the unusually large eye.

In life the dorsal coloration is uniform dark green; undersurface lighter green, with throat and anterior gastrosteges yellowish.

Scale counts are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 78905 | ♀ | 12 | 155 | 148c | ÷ | 8–9 | 10–11 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78906 | ♂ | 12 | 146 | 144+ | ÷ | 9–9 | 11–x | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78907 | ... | 12 | 152 | 139+ | ÷ | 9–8 | 9–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78908 | ♀ | 12 | 152 | 144+ | ÷ | 9–9 | 10–11 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78909 | ♂ | 12 | 147 | 29+ | ÷ | 9–9 | 11–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78910 | ♀ | 12 | 151 | 128+ | ÷ | 9–9 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |

### **Leptophis occidentalis occidentalis** (Günther)

One of the commoner species about Boquete, where thirteen specimens were taken. Strictly confined to the heavy-growth areas in close proximity to water it was found on the floor of the Caldera Valley, islets in the Caldera River, and along the edge of streams in the mountainous sections above the valley floor. This snake is striking in coloration. The body is uniform green, so intense that it is conspicuous even against the luxuriant tropical foliage.

A male (C.A.S. No. 78911) was colored in life as follows: dorsal surface uniform light green; a black band from the corner of the eye to the corner of the jaw; undersurface uniform green, but of a lighter shade than the dorsal coloration.

Scale counts are as follows:

| No. | Sex | Scale Rows | Gastro-steges | Uro-steges | Anal | Supra-labials | Infra-labials | Pre-oculars | Post-oculars | Loreal | Temporals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 78911 | ♂ | 15 | 159 | 91+ | ÷ | 10–9 | 11–11 | 2–2 | 2–2 | abs. | 1+2–1+2 |
| 78912 | ♀ | 15 | 165 | 167c | ÷ | 9–9 | 9–11 | 1–1 | 2–2 | " | 1+2–1+2 |
| 78913 | ♀ | 15 | 167 | 74+ | ÷ | 9–9 | 11–11 | 1–1 | 2–2 | " | 1+2–1+2 |
| 78914 | ♀ | 15 | 163 | 99+ | ÷ | 9–10 | 10–10 | 1–1 | 2–2 | " | 1+1–1+1 |
| 78915 | ♂ | 15 | 162 | 135+ | ÷ | 8–8 | 9–9 | 1–1 | 2–2 | " | 1+1–1+1 |
| 78916 | ♂ | 15 | 161 | 131+ | ÷ | 9–9 | 9–10 | 1–1 | 2–2 | " | 1+2–1+2 |
| 78917 | ♂ | 15 | 160 | 157c | ÷ | 9–9 | 11–11 | 2–1 | 2–2 | " | 1+2–1+1 |
| 78918 | ♀ | 15 | 164 | 152+ | ÷ | 8–8 | 10–11 | 1–1 | 2–2 | " | 1+1–1+2 |
| 78919 | ♀ | 15 | 170 | 167c | ÷ | 10–9 | 10–10 | 1–1 | 2–2 | " | 1+2–1+2 |
| 78920 | ♂ | 15 | 165 | 149+ | ÷ | 9–9 | 11–11 | 1–1 | 2–2 | " | 1+2–1+2 |
| 78921 | ♀ | 15 | 160 | 152+ | ÷ | 8–8 | 10–9 | 1–1 | 2–2 | " | 1+1–1+2 |
| 79034 | ♀ | 15 | 163 | 120+ | ÷ | 9–9 | 11–11 | 1–1 | 2–2 | " | 1+2–1+2 |
| 79035 | ♂ | 15 | 168 | 118+ | ÷ | 10–9 | 11–11 | 1–1 | 2–2 | " | 1+2–1+2 |

### **Leimadophis taeniurus juvenalis** Dunn

This strikingly colored snake was not confined to any particular type of country, but was usually found on open roads and amongst debris in the cafetals. It proved to be one of the commoner species, fifteen specimens having been collected. A majority of the stomachs contained small tadpoles.

In life the dorsal surface appeared as metallic bronze, the anterior portion of the body showing each scale with a red border at the top. The throat is yellow. The undersurface is whitish anteriorly and red posteriorly, with numerous black spots. The undersurface of the tail is red. The stretched skin of the snake will show a ground color of red, with greenish-bronze cross-bands.

Scale counts are as follows:

| No. | Sex | Scale Rows | Gastro-steges | Uro-steges | Anal | Supra-labials | Infra-labials | Pre-oculars | Post-oculars | Loreal | Temporals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 78922 | ♂ | 17 | 140 | 58c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78923 | ♀ | 17 | 136 | 61c | ÷ | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78924 | ♂ | 17 | 140 | 55c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78925 | ♀ | 17 | 142 | 57c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78926 | ♀ | 17 | 138 | 53c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78927 | ♂ | 17 | 140 | 56c | ÷ | x–8 | 10–10 | x–1 | x–x | x–1 | x–1+2 |
| 78928 | ♂ | 17 | 141 | 41+ | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78929 | ♂ | 17 | 142 | 65c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78930 | ♂ | 17 | 137 | 58c | ÷ | x–x | x–x | 1–x | 2–x | 1–x | x–x |
| 78931 | ♀ | 17 | 141 | 58c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78932 | ♀ | 17 | 141 | 57c | ÷ | x–8 | x–10 | 1–1 | 2–x | 1–1 | x–x |
| 78933 | ♂ | 17 | 142 | 53c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78934 | ♂ | 17 | 143 | 55c | ÷ | 8–8 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78935 | ♂ | 17 | 142 | 59c | ÷ | 8–8 | x–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 78936 | *juv.* | 17 | 132 | 59c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |

### **Lampropeltis triangulum gaigae** Dunn

A rare species about Boquete, only a single specimen being taken during four months in the field. This is a juvenile showing the red, white, and black banded type of coloration, the adults, as stated by Dunn[1], being black. On the dorsal surface the red bands are 4–4½ scales wide, white bands 2–2½ scales wide, and the red bands 13–13½ scales wide. The top of the head is black, with a white band across the snout.

Discovered on a main road on the outskirts of Boquete.

### **Trimetopon slevini** Dunn

A male, No. 78938, taken near Boquete at an elevation of 4,000 feet has the following scale counts: scale rows 17, gastrosteges 155, urosteges 58, anal divided, supralabials 7–7, infralabials 8–8, preoculars 1–1, postoculars 2–2, loreal 1–1, temporals 1–1.

### **Hydromorphus dunni** Slevin, new species

A specimen of *Hydromorphus* differs so markedly from the two recorded specimens of *Hydromorphus concolor*, the only species heretofore known in the genus, that it is here described as new.

*Description:* Gastrosteges 164; urosteges 52c; scales in 15-15-13 rows, smooth, without pits; anal 2; supralabials 6-6; infralabials 8-8. On the right side of the head the loreal enters the eye under a small upper preocular, while on the left side it is entirely separated by two preoculars. The postoculars are 2-2; temporals 1+2 – 1+2; prefrontals 3, the median one being small; internasals 2; 3 infralabials in contact with anterior chinshields; nasal directed upward in a single plate.

The dorsal scales of the anal region are occupied by white keels or tubercles, the largest on the first scale row and extending for fourteen scales anterior and four posterior to the vent. On the fourth row they are on nine scales anterior to the vent.

Color above uniform olive; undersurface of body yellowish, with dark gray spotting on the outer edges of the gastrosteges; undersurface of tail grayish.

*Type:* No. 78939 Mus. Calif. Acad. Sci., **Vicinity North of Boquete, Chiriqui Province, Panama.** Collected by Joseph R. Slevin, July 30, 1939. Named for Dr. Emmett R. Dunn, who is so intimately connected with Central American herpetology.

### **Geophis brachycephala** (Cope)

By far the most abundant species met with in the vicinity of Boquet, where 63 specimens were found in the cafetals as they were being cleared previous to coffee picking. Stomach contents showed beetle remains.

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[1]Occ. Papers Museum Zool. Univ. Mich., No. 353, p. 9, April 28, 1937.

In the present series there are four types of coloration. While all have a dorsal ground color of light to dark slate and whitish undersurfaces, the following variations are found:

36 specimens show reddish spots, blotches or short stripes,
23 specimens are uniform in color,
2 specimens show a white collar and no lateral spots,
2 specimens show a white collar and red lateral spots.

With the exception of a damaged specimen, which was not counted, all have scales in 15 rows, anal single, supralabials 6–6, preoculars 1–1, postoculars 2–2, temporals 1–1, loreal absent.

Sexes and variations in scale counts are as follows:

| *No.* | *Sex* | *Gastrosteges* | *Urosteges* | *Infralabials* |
|---|---|---|---|---|
| 78940 | ♀ | 129 | 36c | 6–7 |
| 78941 | ♂ | 126 | 39c | 7–6 |
| 78942 | *juv.* | 125 | 36c | x–7 |
| 78944 | ♂ | 129 | 37c | 6–6 |
| 78945 | ♂ | 126 | 35+ | 7–7 |
| 78946 | ♀ | 132 | 35c | 7–7 |
| 78947 | ♀ | 128 | 35c | 7–7 |
| 78948 | ♀ | 131 | 35c | 7–7 |
| 78949 | x | 125 | 36c | 6–6 |
| 78950 | ♂ | 127 | 38c | 6–6 |
| 78951 | ♀ | 131 | 35c | 6–7 |
| 78952 | ♂ | 126 | 40c | 7–7 |
| 78953 | x | 125 | 37c | 6–7 |
| 78954 | ♀ | 129 | 34c | 6–6 |
| 78955 | ♂ | 124 | 40c | 7–7 |
| 78956 | ♀ | 126 | 33c | 6–6 |
| 78957 | x | 123 | 38c | 6–6 |
| 78958 | x | 124 | 35c | 6–6 |
| 78959 | ♂ | 125 | 39c | 6–6 |
| 78960 | *juv.* | 121 | 37c | 7–7 |
| 78961 | " | 126 | 36c | 7–7 |
| 78962 | ♂ | 125 | 39c | 7–7 |
| 78963 | ♀ | 127 | 35c | 6–6 |
| 78964 | ♀ | 123 | 34c | 6–7 |
| 78965 | ♀ | 127 | 33c | 6–6 |
| 78966 | *juv.* | 130 | 38c | 6–7 |
| 78967 | ♀ | 129 | 35c | 6–7 |
| 78968 | ♂ | 127 | 38c | 6–6 |
| 78969 | ♂ | 125 | 38c | 6–6 |
| 78970 | *juv.* | 125 | 36c | x–7 |
| 78971 | ♂ | 125 | 40c | 6–6 |
| 78972 | ♂ | 125 | 39c | 6–6 |
| 78973 | ♀ | 130 | 33c | 6–6 |
| 78974 | ♂ | 121 | 39c | 6–6 |
| 78975 | ♀ | 125 | 33c | 6–6 |

| No. | Sex | Gastro-steges | Uro-steges | Infra-labials |
|---|---|---|---|---|
| 78976 | ♀ | 118 | 28c | 6 – 6 |
| 78977 | ♀ | 130 | 26c | 6 – 6 |
| 78978 | ♂ | 128 | 24+ | 6 – 6 |
| 78979 | *juv.* | 136 | 44c | 6 – 6 |
| 78980 | ♀ | 126 | 34c | 6 – 6 |
| 78981 | x | 129 | 30+ | 6 – 6 |
| 78982 | ♀ | 128 | 34c | 6 – 7 |
| 78983 | ♂ | 142 | 46c | 6 – 6 |
| 78984 | ♂ | 122 | 38c | 6 – 6 |
| 78985 | *juv.* | 119 | 36c | 6 – 6 |
| 78986 | " | 126 | 40c | 6 – 6 |
| 78987 | x | 130 | 34c | 7 – 7 |
| 78988 | ♂ | 123 | 41c | 6 – 7 |
| 78989 | ♂ | 126 | 40c | 6 – 6 |
| 78990 | *juv.* | 123 | 38c | 6 – 6 |
| 78991 | ♀ | 130 | 34c | 6 – 6 |
| 78992 | ♀ | 125 | 34c | 6 – 6 |
| 78993 | ♀ | 127 | 34c | 6 – 6 |
| 78994 | ♀ | 125 | 33c | 6 – 6 |
| 78995 | ♀ | 126 | 33c | 6 – 6 |
| 78996 | ♀ | 125 | 33c | 6 – 6 |
| 78997 | ♀ | 130 | 38c | 6 – 6 |
| 78998 | x | 125 | 38c | 6 – 6 |
| 78999 | *uv.* | 123 | 37c | 7 – 7 |
| 79000 | " | 127 | 40c | 7 – 7 |
| 79001 | " | 125 | 38c | 7 – 7 |
| 79033 | " | 121 | 30c | x – x |

## **Sibon sibon** (Linnaeus)

Two specimens were brought in by a native, and the habitat could not be ascertained. The ground color, in life, is grayish, with cross-bands of black bordered by a white line one scale wide. The undersurface of the body is whitish, with minute black spots and alternating black blotches. The undersurface of the tail is black, with white spotting.

Scale rows are as follows:

| No. | Sex | Scale Rows | Gastro-steges | Uro-steges | Anal | Supra-labials | Infra-labials | Pre-oculars | Post-oculars | Loreal | Temporals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 79002 | ♂ | 15 | 184 | 89c | 1 | 7 – 7 | 8 – 8 | 1 – 1 | 2 – 2 | abs. | 1+2 – 1+2 |
| 79003 | ♀ | 15 | 172 | 81c | 1 | 7 – 7 | 8 – 9 | 1 – 1 | 2 – 2 | " | 1+2 – 1+3 |

### **Imantodes cenchoa** (Linnaeus)

Probably not an uncommon species in the vicinity of Boquete, but owing to its secretive, nocturnal habits it is somewhat difficult to find. Two specimens were taken from the dense foliage in the coffee trees, one was found crawling along a barbed wire fence at night, and another under a large dead leaf, which had fallen from a tree onto a lawn, while a fifth was found in a bromelia.

In life the ground color is grayish, with large reddish-brown bands extending over the sides and reaching the gastrosteges. Undersurfaces grayish or whitish, with minute brownish spots. C.A.S. Nos. 79004 and 79008 have a reddish longitudinal line down the middle of the gastrosteges.

Scale counts are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 79004 | ♂ | 17 | 261 | 164c | ÷ | 8−8 | 10−10 | 1−1 | 3−3 | 1−1 | 2+4−2+3 |
| 79005 | ♂ | 17 | 255 | 117+ | ÷ | 8−8 | 9−10 | 1−1 | 3−3 | 1−1 | 2+3−2+3 |
| 79006 | ♀ | 17 | 243 | 151+ | ÷ | 8−8 | 10−10 | 1−1 | 2−3 | 1−1 | 2+3−2+3 |
| 79007 | ♀ | 17 | 240 | 150c | ÷ | 8−8 | 9−10 | 1−1 | 2−2 | 1−1 | 2+2−2+2 |
| 79008 | ♀ | 17 | 241 | 170c | ÷ | 8−8 | 10−10 | 1−1 | 3−2 | 1−1 | 2+3−2+2 |

### **Oxybelis acuminatus** (Wied)

Three specimens were taken from bushes in open pasture land. Like *Imantodes cenchoa* it is a difficult snake to discover in thick foliage.

In life the ground color is a light reddish-bronze, with occasional minute black spots; a narrow black line passes through the eye and along the upper edge of the labials; undersurface of body anteriorly greenish-yellow, posteriorly brownish; undersurface of tail brownish.

### **Erythrolamprus bizonus** Jan

Of the three specimens taken one was found in a rock wall a few feet above the waters of the Caldera River, and two along the banks of a stream above the floor of the Caldera Valley.

The brilliantly red and black banded snake has the black bands in pairs and the red ones heavily marked with black. The bands completely encircle the body and tail. The top of the head and neck is black, with considerable white edging on the head plates. C.A.S. Nos. 79013 and 79014 have a narrow white collar across the neck.

Scale counts are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 79012 | ♂ | 15 | 193 | 57c | ÷ | 7–7 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 79013 | ♂ | 15 | 193 | 59c | ÷ | 7–7 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 79014 | ♂ | 15 | 191 | 58c | ÷ | 7–7 | 9–9 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |

## **Coniophanes fissidens fissidens** (Günther)

Probably not common about Boquete, only two specimens having been taken, one brought in by a native woman and the other found under a stone on the banks of the Caldera River. In life the dorsal coloration of these two snakes was a very light brown, with a pinkish tinge. In alcohol this has changed to a uniform light brown. A white stripe, with a very narrow black border above, extends from the eye to the neck. C.A.S. No. 79105 has a faint trace of a black dorsal line. The undersurfaces are whitish, with minute black spots.

Scale counts are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 79015 | ♂ | 21 | 127 | 82c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |
| 79016 | ♂ | 21 | 122 | 71c | ÷ | 8–8 | 10–10 | 1–1 | 2–2 | 1–1 | 1+2–1+2 |

## **Stenorhina degenhardtii** (Berthold)

A single specimen was dug from the ground while clearing land for a garden, and three were found along the banks of a stream above the floor of the Caldera Valley.

All four are of the cross-barred type of coloration. In life the ground color was reddish-brown, with cross bands of black. The undersurfaces were yellowish heavily spotted with black, with the exception of the throat which is without markings.

Scale counts are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 79017 | ♀ | 17 | 163 | 38c | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | 1–x | 1+2–1+2 |
| 79018 | ♀ | 17 | 156 | 50c | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | abs. | 1+2–1+3 |
| 79019 | *juv* | 17 | 170 | 38c | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | " | 1+2–1+2 |
| 79020 | " | 17 | 169 | 34c | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | " | 1+2–1+2 |

## **Micrurus nigrocinctus nigrocinctus** (Girard)

Nine specimens, found under stones in pasture lands and on open roads in the vicinity of Boquete, constitute the present series.

Unlike the northern form, *M. n. zunilensis*, from Guatemala, the red bands are heavily pigmented with black and the white bands much more pronounced, being 2–2½ scales in width. Adult males show conspicuous supra-anal keeling.

Scale counts are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* | *Temporals* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 79021 | *juv* | 15 | x | 34c | ÷ | x–7 | 7–7 | x–1 | x–2 | abs. | 1+1–1+1 |
| 79022 | ♀ | 15 | 217 | 38c | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | " | 1+1–1+1 |
| 79023 | ♀ | 15 | 229 | 33+ | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | " | 1+1–1+1 |
| 79024 | ♂ | 15 | x | 51c | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | " | 1+1–1+1 |
| 79025 | *juv* | 15 | 225 | 35c | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | " | 1+1–1+1 |
| 79026 | " | 15 | 212 | 51c | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | " | 1+1–1+1 |
| 79027 | ♀ | 15 | 217 | 39c | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | " | 1+1–1+1 |
| 79028 | ♂ | 15 | 197 | 46c | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | " | 1+1–1+1 |
| 79029 | ♂ | 15 | 208 | 52c | ÷ | 7–7 | 7–7 | 1–1 | 2–2 | " | 1+1–1+1 |

### **Trimeresurus lateralis** (Peters)

One of the rare snakes about Boquete. Three individuals were seen, but only two collected, the third escaped in the swift waters of the Caldera River as it dropped into the rushing torrent from an overhanging limb. Of the two taken one was found in the heavy foliage along the river, and one in a coffee tree about a thousand feet above. In life the ground color is uniform green, a somewhat lighter shade underneath. A narrow yellow line extends along the outer row of scales, engaging the tips of the gastrosteges.

Scale counts are as follows:

| *No.* | *Sex* | *Scale Rows* | *Gastro-steges* | *Uro-steges* | *Anal* | *Supra-labials* | *Infra-labials* | *Pre-oculars* | *Post-oculars* | *Loreal* |
|---|---|---|---|---|---|---|---|---|---|---|
| 79030 | ♂ | 21 | 169 | 56c | 1 | 9–8 | 12–12 | 2–2 | 3–3 | 1–1 |
| 79031 | ♀ | 23 | 166 | 55c | 1 | 10–10 | 12–12 | 2–2 | 3–3 | 1–1 |

PLATE 39

Fig. 1. Trail in the vicinity north of Boquete, Panama. The type of *Hydromorphus dunni* was taken at the base of the Yucca-like plant at the right-hand side. This locality is also the habitat of *Ninia psephota, Dendrophidion paucicarinatus, Geophis brachycephala,* and *Stenorhina degenhardtii.*

Fig. 2. Top of head *Hydromorphus dunni.*

Fig. 3. Side view of anal region *Hydromorphus dunni.*

PLATE 40

Fig. 1. A road in the Caldera Valley north of Boquete. Along this road were taken *Anolis copei, Anolis polylepis, Ameiva quadrilineata, Ninia maculata, Dryadophis boddaertii alternatus, Leimadophis taeniurus juvenalis, Imantodes cenchoa,* and *Micrurus nigrocinctus nigrocinctus.*

Fig. 2. Vegetation on the north slope of the Volcan Chiriqui at about 7,000 feet. *Anolis pachypus* and *Anolis microtus* occur at this point.

PLATE 41

Fig. 1. Coffee trees on an island in the Caldera River. In these trees were found *Anolis intermedius, Drymarchon corais melanurus,* and *Imantodes cenchoa. Mabuya mabuya mabuya* was found on the stump at the left of the picture.

Fig. 2. The Caldera River about two miles above Boquete. *Trimeresurus lateralis* was found on the bank of the river opposite the large rock in the center. It was a common sight to see *Basiliscus basiliscus* sitting on the tops of rocks such as this, and on the smaller ones adjacent to it.

PLATE 42

Fig. 1. The crater of the Volcan Chiriqui 10,000 feet above sea-level. *Gerrhonotus monticola* was found in the patches of grass scattered on the crater floor.

Fig. 2. The Caldera River just to the northward of Boquete. The habitat of *Leptohis occidentalis occidentalis, Erythrolamprus bizonus,* and *Spilotes pullatus pullatus.* A large male *Spilotes* was shot from the dead limb seen in the center of the picture.

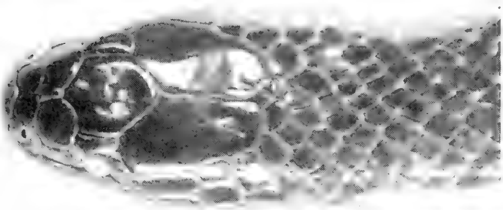

Fig. 2

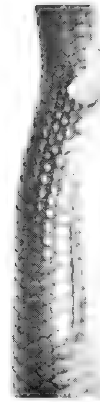

Fig. 3

Fig. 1

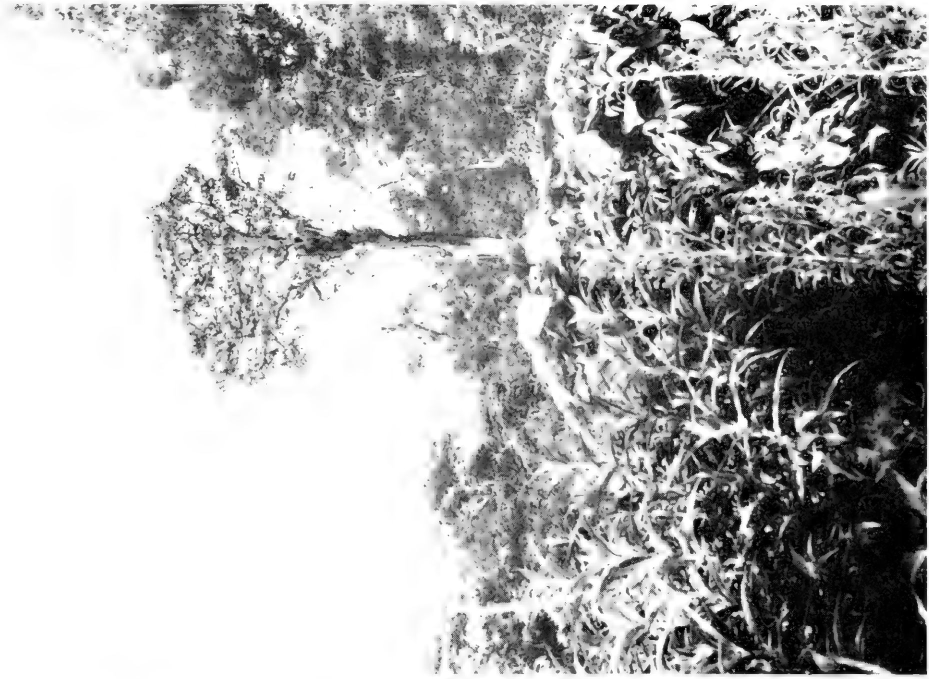

Fig. 2

Fig. 1

Fig. 1

Fig. 2

Fig. 1

Fig. 2

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# REDESCRIPTION OF THREE SPECIES OF THE POLYCHAETOUS FAMILY POLYNOIDAE FROM CALIFORNIA*

BY

TAGE SKOGSBERG
*Hopkins Marine Station*

## INTRODUCTION

Our knowledge of the marine invertebrates on the west coast of North America is, generally speaking, very incomplete and uncertain. Such regions as the European seas and the waters off the coast of New England were explored faunistically in an intensive manner for a long period before the birth of modern experimental biology. The period of predominantly faunistic exploration was comparatively short on the west coast of North America for two reasons: first, the biological sciences began to flourish rather late in that region and, second, they soon became nearly exclusively experimental. Some of the invertebrate groups of the west coast of North America, such as the Echinoderms, the decapod Crustacea, and a few others, have been submitted to competent analyses, but the great majority of the groups have been woefully neglected. One of the latter category is the polychaetous annelids. Several years ago, the author of this report undertook a study of these worms, but circumstances prevented the continuation of this work. In order that at least some of the results obtained may be made useful, the present report was prepared.

A most serious obstacle in the road of anybody who attempts to identify polychaetous worms is the confused state of the bulk of the literature, not only that pertaining to the forms living on the west coast of North America, but also that of the group in general. The delimitations of many of the genera are extremely vague, and a great number of the species are described so incompletely that their

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identification becomes either tentative or even impossible. A new, broader, and more secure foundation for the taxonomy must be established. The generic descriptions must be as inclusive as possible and the species must be dealt with much more in detail. In other words, a much larger number of characters should be examined and descriptions should contain the fullest possible accounts not only of the more or less constant features but also of the variable ones. It is, of course, well known that characters behave differently in the different groups. For instance, while in one group a certain feature is very variable, being perhaps different even on the right and left sides of one and the same individual, in closely related groups it may be relatively or nearly absolutely constant. Statements in regard to the relative variability of the various characters will help us to reach not only a better understanding of the taxonomy of the group studied, but it will also promote a better insight in the evolutionary processes.

Polynoidae, the family to which the species treated below belong, is very well represented in California. About fifty species, belonging to thirteen genera, have been described so far, a very large number, indeed, even if some of them must be reduced to the status of synonyms. Many of these species appear to be very variable and a thorough revision of all of them is necessary. The present paper is a small contribution towards this end. In the following descriptions, consideration has been given to the variability of the characters. It should be observed that the descriptions have been standardized. In order to facilitate comparisons the characters have been presented in a standard order and the phraseology has been stereotyped. Characters not mentioned in the descriptions are supposed to be generic in nature. Due to the limitation of specific material, no attempt at generic description and analysis has been made.

## **Halosydna brevisetosa** Kinberg

Plate 43; text figure A

*Halosydna brevisetosa*, KINBERG, 1855, p. 385; 1857-1910, p. 18; BAIRD, 1865, p. 186; MOORE, 1909, p. 240; TREADWELL, 1923, p. 4; SEIDLER, 1924, p. 125.

*Polynoë brevisetosa*, JOHNSON, 1897, p. 167; *non* TREADWELL, 1902, p. 186.

*Lepidonotus insignis*, BAIRD, 1863, p. 106.

*Polynoë insignis*, JOHNSON, 1901, p. 387.

*Halosydna insignis*, MOORE, 1908, p. 330; 1910, p. 329; TREADWELL, 1914, p. 180; CHAMBERLIN, 1918, p. 173; 1919, p. 252; 1928, p. 311; BERKELEY, 1935, p. 767.

*Lepidonotus grubei*, BAIRD, 1863, p. 107.

*Halosydna grubei*, BAIRD, 1865, p. 189.

*Description:* The largest free-living specimen measured by me was 61 mm long, while the largest commensal one was not less than

100 mm; see also below, under the heading "Remarks." Some specimens are rather robust, while others are fairly slender; robust and more or less slender shapes occur among the small as well as among the large specimens. Ratio between the length and the greatest width of body (measured between tips of parapodia, exclusive of bristles) is 6.0 (4.9–7.1):1. Usually the body tapers slightly posteriorly; anterior and posterior extremities well rounded. Setigerous somites 36, as usual in the genus. In only one specimen 37 setigerous somites were found; the supernumerary somite, just in front of the pygidium, was very small, and of its small parapodia each contained only one bristle, the aciculum. The elytra may cover the body nearly completely; generally, however, the members of each pair barely touch each other and sometimes a zone, about half as wide as each of the corresponding elytra, is naked along the median line. Prostomium may be exposed, but in about 90% of the specimens examined it was completely covered by the first pair of elytra. The anus, which is located on somite XXXV or between somites XXXIV and XXXV, or else between somites XXXV and XXXVI, was covered by elytra in about 80% of the specimens examined.

Prostomium, measured from base of ceratophore of median tentacle, about 1.4 to 1.8 times wider than long and usually widest at about the middle; sometimes its greatest width is located just in front of or somewhat behind the middle. Its lateral outlines either moderately and evenly convex, or more or less rounded angular. It is slightly grooved along the mid-dorsal line; usually the fine and narrow groove can be detected only just behind median ceratophore, but sometimes it can be seen also at the posterior end of prostomium; only in a few specimens can it be traced along the entire mid-dorsal line. Ceratophores of the lateral tentacles about 0.5–0.7 as long as the prostomium, approximately twice as long as wide, and not quite so long as ceratophore of median tentacle. Prostomium, always with two pairs of fairly large eyes, located on its posterior half, the members of each pair being far apart. In a few specimens there are also two pigmented spots which may easily be mistaken for eyes, and which are located postero-laterally to the anterior pair of eyes. The lateral tentacles about twice as long as the prostomial protuberances (ceratophores) on which they are located, and about half as long as the median tentacle or somewhat less; of moderate thickness, and either cylindrical or slightly bulbous distally; their distal filamentous appendage about as long as or slightly longer than their width; always smooth. Ceratophore of the median tentacle subobovoidal, truncated anteriorly, and about 1.1–1.5 times longer than wide. Median tentacle of about the same shape and structure as the lateral, and about 2.5–3.5 times longer than its ceratophore. Along the postero-dorsal margin of the prostomium, there is frequently a narrow, slightly pigmented zone. Prostomial protuberances usually quite heavily pigmented, except distally where they sometimes completely lack pigment. Lateral tentacles more or less heavily pigmented proximally and with a dark, subterminal zone; in the middle the pigment may be absent or developed to varying degrees. Ceratophore of median tentacle always more or less pigmented proximally, and frequently more or less lightly colored distally. Pigmentation of median tentacle approximately the same as that of lateral tentacles.

The palpi are whitish. Even in the darkest specimens observed by me, no pigment was detected. However, according to Johnson (1897, p. 167), they are somewhat pigmented in very dark specimens; the darkest specimens found by this author were commensal (see below, under "Remarks"). The palpi are thickest near the base and taper very gradually to a fine point; about as long as or somewhat longer than the median tentacle in preserved specimens, but extremely contractile, "being about thrice the length of the tentacle when fully extended" (Johnson, 1897). They are beset with a varying number of exceedingly minute papillae which apparently always are arranged irregularly, frequently very numerous and closely set, but sometimes more or less widely spaced.

When fully everted, the proboscis is cylindrical, about twice as long as wide or somewhat less; its anterior edge with 18 papillae, 9 of which are dorsal and 9 ventral. The papillae are subequal in size, or those near the median plane are somewhat larger than the lateral ones. When seen from the outside, they appear leaf-like or triangular, but they have on the inside a large, mammilliform process. The proboscis either lacks or has a very slight pigmentation. In the mouth, there are two pairs of fairly large, subequal, triangular teeth, one dorsal and one ventral pair. The members of each pair are located close together on either side of the median plane. To the outside of each of the four teeth a fairly large, chitinous plate is attached, the outer edge of which is free and appears to be cutting; the right and left members of each of these pairs of plates can be pressed against each other (Pl. 43, figs. 7, 8).

The uniramous, first parapodium is pigmented, and has 1–3 fine, simple, and rather short bristles which are pectinated along the greater part of the length. Its two cirri are either subequal in length, or the ventral is slightly shorter; they have about the same pigmentation as the lateral tentacles, or the pigment in the middle is somewhat less developed. All cirri smooth. Dorsal cirri are present on the following somites: III, VI, VIII, and on alternate somites to XXVI inclusive, and then on XXIX, XXXII, XXXIV, XXXV, and XXXVI. Each of the cirri has a subconical cirrophore, about as large as or somewhat larger than the ceratophore of the median tentacle. The cirrophores usually somewhat pigmented, each having a subterminal zone of pigment and generally also some pigment proximally. Ventral cirrus of second somite may have nearly the same pigmentation as the cirri of the first somite, but in most specimens it is more or less devoid of pigmentation. The remaining ventral cirri about as long as or slightly longer than the cirrophores of the dorsal cirri, subulate, and usually without pigment.

Notopodia small, only about 0.2 or less the length of neuropodia, with bristles in 3 subhorizontal rows, all placed somewhat dorsally to aciculum. In most somites, there are 5 or 6 bristles in the most dorsal row, seldom 4 or 7 are found; in the middle row, there are 5–9; and in the ventral row, 5–10 bristles; the middle and ventral rows are so closely placed that their bristles are difficult to count with full certainty. In the last few somites the number of bristles frequently is decidedly less than in the remaining ones. Bristles in the middle and ventral rows extend at the most to or very slightly beyond tip of neuropodium, and are about 2–5 times longer than those of the dorsal row; they end in a long and very fine point and have fine frills along the greater part of their length. Bristles of the dorsal row very short, with fine frills along their entire free portion, and end in a short, strong point. Neuropodia are strong, subquadrangular, obliquely truncate, and armed with setae placed in two groups, one on either side of aciculum; their surface not pitted. In the dorsal group there are usually 5-9, in the ventral group 9-15 bristles; the numbers may, however, be somewhat smaller. The bristles are decidedly stronger than those of the notopodia, and about as long as the neuropodia or somewhat shorter; straight except distally, where they are gently curved; with simple, pointed, or more or less blunt tip; and furnished somewhat below the tip with about 8-15 frills of which the distal ones bear very strong, the remaining ones exceedingly fine spines; in the last few parapodia the bristles frequently are very short and few. In the second somite the bristles sometimes are somewhat more numerous than in the remaining ones, and they have a structural type approaching that of the bristles of the notopodia. Notopodium frequently more or less pigmented; neuropodium always lacks pigment.

The two cirri of the pygidium of about the same size, shape, structure, and pigmentation as the dorsal cirri of most segments.

The typical pre-elytrophore resembles the elytrophore but is somewhat smaller and lower and, of course, lacks the cup like structure onto which the elytron is attached.

The nephridial papillae are rather prominent, approximately as long as the ventral cirri are wide, somewhat longer than wide, well rounded or truncate distally, and slightly fluted. They begin on somite VIII and cease either on somite XXXV or on somite XXXVI (about 50% of the specimens examined had papillae on somite XXXVI); thus in all there are either 28 or 29 nephridial papillae.

In dark specimens there are two cross bars of pigments, on most of the segments, one of which may extend across the larger part of the width of the body; in light colored specimens these cross bars may be in part absent. The ventral aspect of the body is not pigmented, or is washed with ashy grey in melanistic individuals.

The elytra, which are very difficult to remove in preserved specimens, are very varied in shape; the first pair is suborbicular, the last pair rounded triangular, and the remaining ones subreniform or subovate to subelliptical; all of them are almost flat; furthermore, the elytra of different specimens show fairly pronounced differences in shape. All elytra have a series of small, short spines

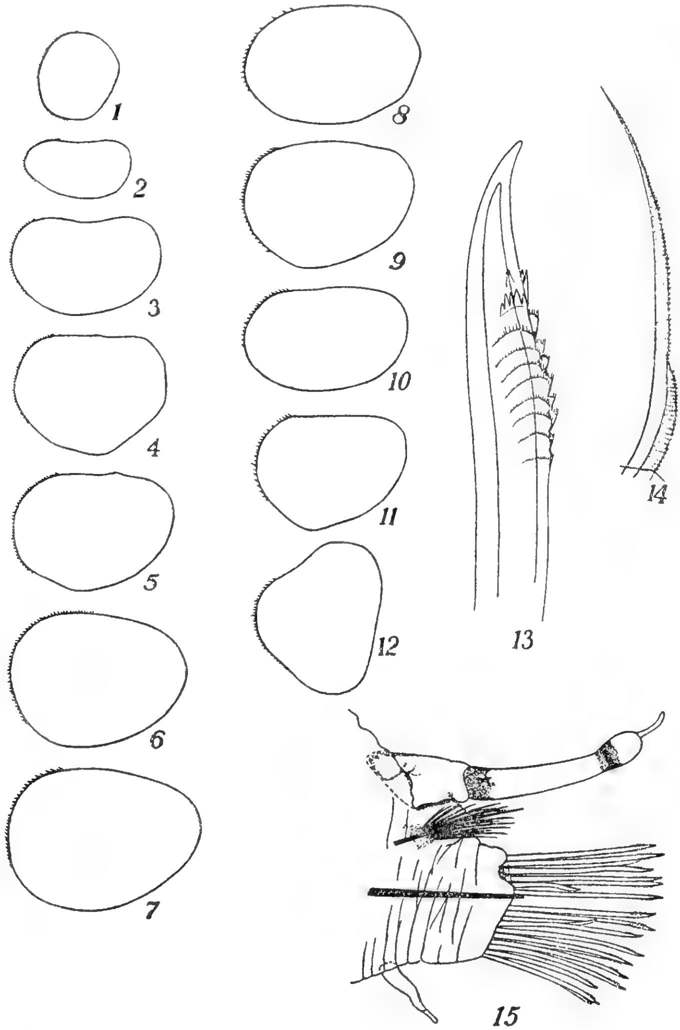


Figure A. *Halosydna brevisetosa* Kinberg. 1–6. Elytra Nos. 1 to 6. Elytron No. 7 of the same shape as No. 6, × 6.5; 7. Elytron No. 8, of same shape as Elytra Nos. 9–13, × 6.5; 8–12. Elytra Nos. 14 to 18, × 6.5; 13. Tip of bristle from neuropodium of 20th parapodium, × 195; 14. Notopodial setae from fifth somite, × 85; 15. Left parapodium of 20th somite, under cover glass, × 17.

on the external border. The first three or four pairs have large, bluntly conical, chitinous tubercles in a moderate number and in addition numerous small tubercles; the remaining ones have only small tubercles. The development of the tubercles is rather strongly variable within the species. Each elytron has a white spot just above the elytrophore, but in other respects its color pattern is highly variable. In most specimens, however, there is a more or less dark spot (black, grey, brown, or orange) just in front of the white ocellus; sometimes this spot lies behind the ocellus, sometimes it is entirely absent. In most specimens the remainder of the elytron is more or less densely mottled with pigments of the kinds mentioned above; and in some this mottling is nearly or completely absent. "Coloration highly variable, but in all cases the fundamental or ground color is white. This is overlaid by pigmented areas of iron-grey, tawny, brown, yellow, or orange. Melanistic specimens are common, in which the iron-grey is intensified to almost jet black, and even the ventral side is dark." This statement by Johnson (1897, p. 168) agrees closely with my own experience.

Sex products appear to be limited to somites XI to XXXIV or XXXV, inclusive.

*Remarks:* The maximum length of the body of free-living specimens given above is based on the measurements of more than one hundred preserved specimens from Monterey Bay and vicinity. Twenty-five specimens from the same region were examined for the following characteristics: ratio between length and width of body; number of somites; number and arrangement of elytra and nephridial papillae; number and distribution of cirri; and the location of anus. The number and types of bristles in all the somites were established in four specimens; the number and types of proboscidial papillae and teeth in seven cases. The relative size, the shape, and the coloration of the elytra were examined in more than thirty specimens. Most of the observations were made on specimens preserved in formalin, but living material was also studied especially in regard to the coloration.

The description given above is based exclusively on free living (non-commensal) specimens taken in tide pools and on piling in Monterey Bay and Carmel Bay, California, thus at a distance of only about 120 miles south of the type locality of *Halosydna brevisetosa*, viz., Sausalito Bay, just inside the Golden Gate at San Francisco. In most respects it agrees quite well with the rather sketchy description and figures given by Kinberg (1857) of this species. However, in some characters important differences are to be recorded. Perhaps the most significant among these is the length of the neuropodial bristles. In Kinberg's plate 5, fig. 25F, the length of these bristles is only a small fraction of the length of the neuropodium (hence the specific name!), while in all the specimens seen by me the lengths of these two structures are subequal. A close scrutiny of this figure, however, suggests that it is at least not excluded that Kinberg drew only the bases of these bristles. This conclusion is apparently borne out by Kinberg's plate 5, fig. 25 G, u, representing a single neuropodial bristle at high magnification. This figure resembles quite closely the neuropodial setae examined by me, but does not agree with these structures in Kinberg's plate 5, fig. 25F. Another important difference is to be found in regard to the notopodial setae (Kinberg's Pl. 5, fig. 25 G, s). According to Kinberg, these setae have strong and rather blunt tips, while I found them characterized by the features represented in my text-figure A, 14. It does not seem impossible to me, however, that both the bristles figured by Kinberg were taken from the neuropodium. A minor difference is to be noted in the shape of the body. The specimen figured by Kinberg (Pl. 5, fig. 25, A) tapered rather strongly posteriorly, while in my material the body had either a subuniform width throughout, or the posterior taper was rather slight. That a doubt about the correctness of my identification may not be out of place is indicated by the fact that other species of the genus do exist in central California. On the other hand, in all probability it is correct, since the region around the type locality is well investigated, and no species has as yet been found which agrees with the peculiarities contained in Kinberg's original description.

It may be noted as a matter of curiosity that in one of the specimens from Monterey Bay, the acicula of the right neuropodia of somites XXIV and XXVI extended to the tips of the respective neuropodial bristles. This condition presumably was the result of an abnormal development.

The species, as conceived in the present paper, is highly variable. The most variable features are the intensity, shade, and pattern of the pigmentation. The shape of the prostomium, and the shape, relative size, and structure of the elytra are also fairly variable. I have made a careful attempt to split the species into smaller units, but without success. In all probability, we are dealing with a single, although variable systematic unit. Johnson (1897) also included in his description a number of specimens found commensally. These commensal individuals evidently differed more or less distinctly from the free-living ones: one of them was not less than 75 mm long, thus distinctly larger than any of the free-living ones in my material. Johnson's commensal specimens also tended to be more slender; their pigmentation usually was heavier, one specimen being nearly black; their elytra were "thinner, smoother, sometimes destitute of any except microscopic tubercles, with few or no marginal 'cilia', etc." Not having had the opportunity of examining any of the specimens referred to this species by Johnson and taken commensally, I am not in the position to judge the correctness of this assignment. However, in all probability, this species, like several other free-living polynoids, tends to assume a commensal existence. One fact worthy of notice in this connection is that all specimens found commensally were old ones; no young ones have ever been seen in this type of habitat. Does this fact indicate that the species tends to become commensal after it has reached a certain age?

*Distribution: Halosydna brevisetosa* is extremely common in the central California waters. In this region it is by far the most common representative of the family in its particular habitat. It seems to prefer rocky bottom between tide marks and just below the tidal region. Here it seeks shelter in crevices, underneath stones, and under or among sessile organisms. Another preferred habitat is under such organisms on piling. The species always seems to seek shelter, a character which perhaps pre-disposes it to a commensal mode of life, *e. g.*, in large worm tubes.

The species extends at least from Alaska to southern California. In southern California, its frequency evidently is low. In regard to its bathymetric range, nothing can be said, except that it has been taken down to a depth of 15-20 meters or even slightly deeper.

Finally, it may be noted that Treadwell (1902, p. 186) recorded the species from Porto Rico. This record, however, requires further checking before it can be accepted.

## **Arctonoë vittata** (Grube)

Text figures B, C, and D, 1–5

*Polynoë vittata*, GRUBE, 1855, p. 82 (Sitka, Alaska; type in Leningrad Museum).

*Lepidonotus lordi*, BAIRD, 1863, p. 107 (Vancouver Island; type in British Museum); 1866, pp. 9, 345.

*Halosydna vittata*, BAIRD, 1865, p. 188.

*Halosydna lordi*, BAIRD, 1865, p. 190; MOORE, 1908, p. 330; TREADWELL, 1914, p. 181; 1926, p. 1; CHAMBERLIN, 1920, p. 9B; BERKELEY, 1923, p. 212.

*Halosydna succiniseta*, HAMILTON, 1915, p. 234.

*Polynoë lordi*, JOHNSON, 1897, p. 175; 1901, p. 388; TREADWELL, 1923, p. 4.

*Acholoë vittata*, MARENZELLER, 1902, p. 576 (north Pacific Ocean).

*Arctonoë lia*, CHAMBERLIN, 1920, p. 6B (Alaska).

*Halosydnoides vittata*, SEIDLER, 1924, p. 134; OKUDA, 1936, p. 565.

*Description:* The largest specimen in my collection measured not less than 100 mm in length, exclusive of prostomial appendages. This specimen, taken in Monterey Bay, thus was nearly twice as long as the largest one measured from the same region by Johnson (1897), who gives 57 mm as the maximum recorded by him. Most specimens are comparatively slender, but fairly robust ones may also be found. Ratio between the length and the width (between tips of parapodia, exclusive of bristles) of the body is 6.5-12.5:1; in the large specimen noted above, it was 12.5:1. Number of chaetigerous somites approximately 70-75 in a specimen about 50-57 mm long; greatest number of such somites recorded was 89. Dorsum broadly exposed between elytra; width of exposed zone frequently subequal to width of the elytra of the measured somite; middle of prostomium usually not covered; and anus is also uncovered.

Prostomium quite variable in shape: in some specimens it is subcircular, truncate anteriorly; in others it is more or less irregular. due to presence of two lateral expansion at or slightly behind middle,

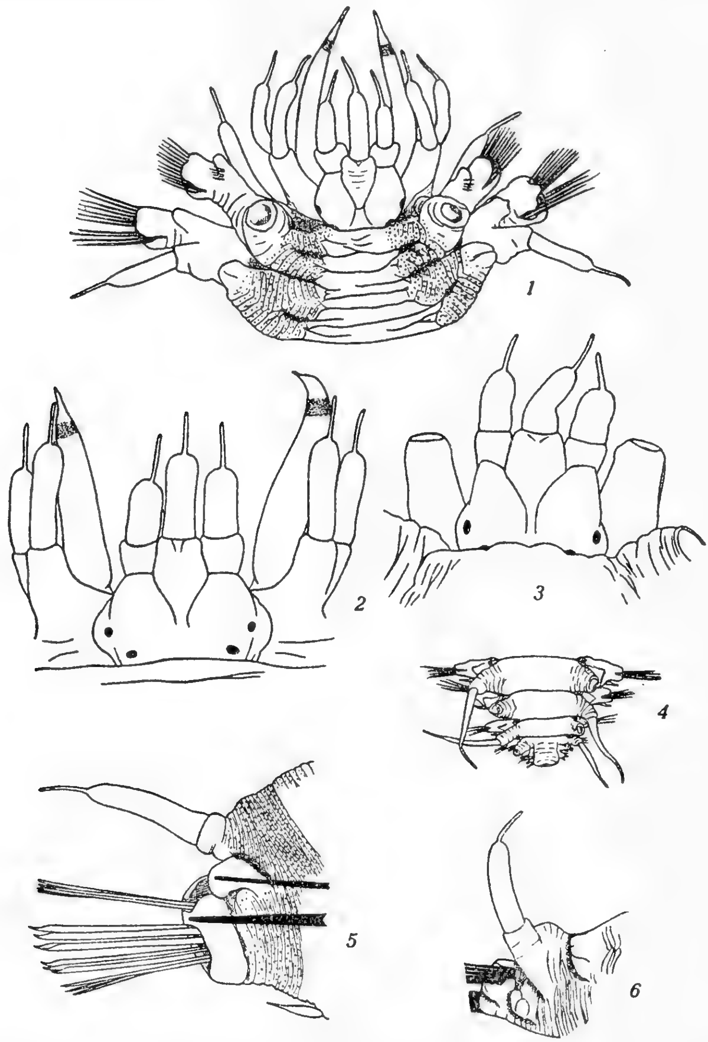


Figure B. *Arctonoë vittata* (Baird). 1. Dorsal aspect of anterior part of body after removal of elytra, × 4.5; 2. Anterior end of body in dorsal view, × 12; 3. Anterior end of body in dorsal view, × 15; 4. Dorsal aspect of posterior part of body after removal of elytra, × 4.5; 5. Right parapodium of 42nd somite; cover glass not used, × 17; 6. Dorsal aspect of right parapodium of 16th somite. To the right of cirrophore a pre-elytrophore is indicated; below the cirrophore and to the right of the bases of the bristles the small notopodium is to be found. × 20. The dots in 1 and 5 indicate small pits and not pigmentation.

It is usually more or less wider than long; widest at or somewhat behind the middle, at about the level of the anterior pair of eyes. It is always bilobed. The two lobes separated anteriorly by ceratophore of median tentacle; posteriorly they are either separated by a shallow groove (Johnson, 1897, pl. 7, fig. 35), or they may merge completely; and anteriorly they are either truncate or obliquely pointed. The two pairs of eyes moderate and subequal in size. Ceratophores of lateral tentacles comparatively large and thick, and about as long as wide. Lateral tentacles short and stubby; when contracted, they are about 1.5–3.0 times longer than their ceratophores and about 1.5–2.5 times longer than wide; the filamentous tip may be somewhat longer than the tentacle proper, but usually it is somewhat shorter. The ceratophore of the median tentacle, which begins at or somewhat behind the middle of the prostomium (its posterior extension frequently not possible to establish with certainty), is truncate anteriorly and either subconical or, and this seems to be the rule, subpentagonal. The median tentacle, which has about the same shape and structure as the lateral ones, either is about as long as or slightly longer than these; i. e., it is, exclusive of the distal filamentous appendage, approximately as long as or somewhat shorter than the prostomium. Prostomium and its appendages whitish, without visible pigment cells.

The palpi, which are whitish with a dark cross band near the tip, are rather thick at the base, tapering gradually to a fine point, and are about 2.5–4.0 times longer than the median tentacle exclusive of its filamentous appendage.

The proboscis, which agrees closely with that of *Halosydna brevisetosa*, may be whitish, or it may have a slight general pigmentation.

The two cirri of the uniramous first parapodium either subequal or the ventral is slightly shorter than the dorsal. Dorsal cirri present on all somites without elytra. Cirrophores of moderate size or rather large, and frequently their proximal portions are more or less swollen; in some specimens the proximal swelling is not present, in which case the cirrophores are subcylindrical, tapering somewhat distally. Dorsal cirri whitish, as are also their cirrophores with the exception of those on the eighth somite which are brownish. Ventral cirri lack pigmentation.

Notopodium small (about $\frac{1}{6}$ or less of neuropodium), rounded verruciform, or somwhat elongated. The one of somite II usually has a varying number (about 4–15) of very short bristles near the base. The ones of somites III-VI either lack bristles or have but a few. The remaining notopodia seem always to lack bristles. The neuropodia, which are more or less truncate distally and somewhat longer to somewhat shorter than thick, have a moderate number of bristles. According to Johnson (1897, p. 176), there are "about 20 setae in all". Two specimens examined by me showed the following numbers on the right side of the body.

*Specimen A* (73 somites):

| | | | | |
|---|---|---|---|---|
| Somite II: | 6 | bristles in the dorsal group and | 20 | in the ventral group; |
| III: | 8 | " " " " " " | 19 | " " " " |
| IV: | 9 | " " " " " " | 18 | " " " " |
| V: | 12 | " " " " " " | 23 | " " " " |
| X: | 8 | " " " " " " | 18 | " " " " |
| XV: | 9 | " " " " " " | 21 | " " " " |
| XX: | 7 | " " " " " " | 13 | " " " " |
| XXV: | 6 | " " " " " " | 15 | " " " " |
| XXX: | 4 | " " " " " " | 5 | " " " " |
| XXXV: | 5 | " " " " " " | 12 | " " " " |
| XL: | 5 | " " " " " " | 11 | " " " " |
| XLV: | 6 | " " " " " " | 11 | " " " " |
| L: | 5 | " " " " " " | 9 | " " " " |
| LV: | 3 | " " " " " " | 11 | " " " " |
| LX: | 4 | " " " " " " | 8 | " " " " |
| LXV: | 4 | " " " " " " | 8 | " " " " |
| LXX: | 2 | " " " " " " | 6 | " " " " |

*Specimen B* (81 somites):

| | | | | |
|---|---|---|---|---|
| Somite II: | 6 | bristles in the dorsal group and | 27 | in the ventral group; |
| III: | 11 | " " " " " " | 21 | " " " " |
| IV: | 9 | " " " " " " | 19 | " " " " |
| V: | 10 | " " " " " " | 20 | " " " " |
| X: | 11 | " " " " " " | 17 | " " " " |
| XV: | 12 | " " " " " " | 18 | " " " " |
| XX: | 9 | " " " " " " | 18 | " " " " |
| XXV: | 8 | " " " " " " | 16 | " " " " |
| XXX: | 6 | " " " " " " | 12 | " " " " |
| XXXV: | 6 | " " " " " " | 14 | " " " " |
| XL: | 5 | " " " " " " | 13 | " " " " |
| XLV: | 5 | " " " " " " | 12 | " " " " |
| L: | 5 | " " " " " " | 11 | " " " " |
| LV: | 4 | " " " " " " | 13 | " " " " |
| LX: | 5 | " " " " " " | 12 | " " " " |

In the remaining segments of specimen B, the number of bristles decreased gradually although irregularly towards the posterior end of the body; at the same time the size and the differentiation of the bristles also declined. In other words, even though the number of bristles within this species is always moderate, it varies very decidedly not only among the individual representatives, but also from one segment to the next.

In somite II all the bristles are of about the same type as those in the dorsal group of the typical parapodia; no hooked bristles are present; the bristles in the dorsal group are slightly heavier than those in the ventral group, and the most ventral of the latter are the finest. In the remaining parapodia the bristles in the two neuropodial groups are different. In the dorsal group the bristles are about as long as or somewhat longer than the distal width of the neuropodium, subequal in length, straight, narrow, somewhat lanceolate distally, with blunt tips, and furnished along the distal part with numerous cross rows of exceedingly fine spines. The bristles in the ventral group are of about the same length as those in the dorsal;

they differ from these in being somewhat hooked and well pointed distally; the distal curvature sometimes is rather slight, sometimes quite pronounced. Some distance from the tip these bristles have a fairly great number of cross rows of exceedingly fine spines. While all the bristles of the dorsal group are of subuniform thickness, those in the ventral group vary in this respect; most of the dorsal ones are comparatively strong, while the ventral are more or less slender, about the same strength as those in the dorsal group. Sometimes some of the bristles of the dorsal as well as of the ventral group are more or less hooded; the hood is transparent and apparently without structure and in the case of the strong bristles it may be quite large. The surface of the parapodia may or may not be pitted. No pigment is present in the parapodia, except in those of somite VIII; see below.

The typical pre-elytrophores are rather small and verruciform; some of the anterior ones are quite large and mammilliform.

The nephridia open on rounded, knob-like papillae which sometimes are so small that they are fairly difficult to detect. They are not distinguishable on the last few somites but distinct on all the other somites from the sixth on; however, these structures are not really well differentiated before somites VIII-IX.

"The dorsum is marked with numerous irregular, transverse bands, lines, and streaks of burnt sienna; the pigment massed in a broad, solid fillet on somites eight and nine." (Johnson, 1897, p. 176). In some of the specimens examined by me the "irregular, transverse bands, lines, and streaks" were not developed; only the "solid fillet" was present. The fillet is developed mainly on somite VIII, and frequently extends onto the parapodia and their notocirri.

The elytra, which are non-deciduous, i. e., difficult to remove from preserved specimens, have a very varied arrangement behind somite XXXIII.

*Specimen A* (73 somites):

2 elytra were present on somite XXXIII and on alternate somites to somite LXV, inclusive, and on somite LXVI; 2 cirri on somite XXXIV and on alternate somites to somite LXIV, inclusive, and on somite LXVII; somites LXVIII, LXX, and LXXII had an elytron on the right side and a cirrus on the left; the reversed condition was found on somites LXIX and LXXI.

*Specimen B* (81 somites):

2 elytra and 2 cirri alternated in a regular manner, such as given for specimen A, from somite XXXIII to somite LXXIV, the latter with 2 cirri; somite LXXV, LXXVII, and LXXIX had an elytron on the right side and a cirrus on the left; and the reversed condition was found on somites LXXVI, LXXVII, and LXXX.

*Specimen C* (89 somites):

2 elytra on somites XXXIII, XXXV, XLIII, XLIX, and on alternate somites from LIII to LXXXVII, inclusive; 2 cirri on somites XXXVI, XLIV, and on alternate somites from LII to LXXXVIII, inclusive; somites XXXIV, XXXVII, XXXIX, XLI, XLVI, XLVIII, and L had an elytron on the right side and a cirrus on the left side; and the reverse was true on somites XXXVIII, XL, XLII, XLV, XLVII, and LI.

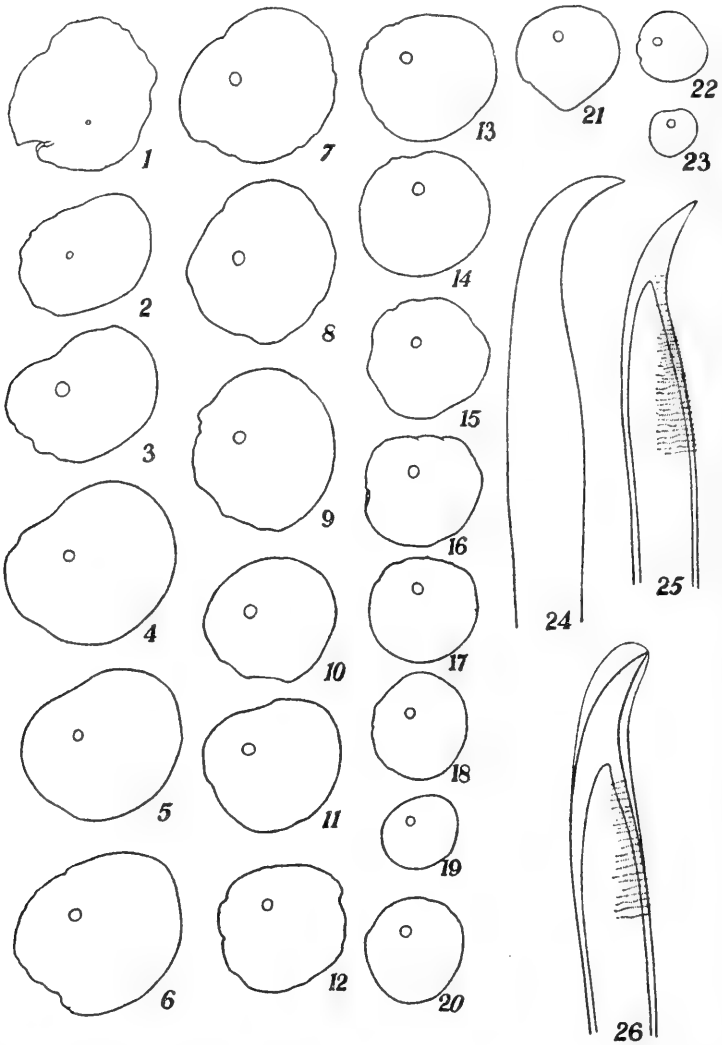


Figure C. *Arctonoë vittata* (Baird). 1–6. Left elytra Nos. 1–6, × 6; 7. Left 7th elytron, × 6. Elytra Nos. 8 and 9 of about the same shape and size as No. 7; 8. Left 10th elytron, × 6. This is of about the same shape but somewhat smaller than No. 11; 9. Left 12th elytron, × 6. No. 13 is slightly smaller and more regular; 10–14. Left 14th–18th elytra, × 6. Elytra No. 19 and 20 rounded and somewhat more irregular than No. 18; 15. Left 21st elytron, × 6. Elytron No. 22 about the same as No. 21; 16. Left 23rd elytron, × 6. Elytron No. 24 somewhat more rounded than No. 23; 17. Left 25th elytron, × 6. Elytra No. 26–28 somewhat more irregular than No. 25; 21. Left 29th–32nd elytra, × 6; 22–23. Left elytra No. 34 and 36, × 6. Elytron No. 33 almost circular, its size intermediate between Nos. 32 and 34; No. 35 similar to No. 34; 24. Heavy bristle in ventral group of right neuropodium of 15th somite, × 195; 25. One of the dorsal bristles in the ventral group of neuropodium of 20th somite, × 195; 26. Same as No. 31, but the bristle furnished with a hyaline hood, × 195.

In all the specimens the last somite had neither elytra nor cirri developed. A characteristic feature of the irregularity is thus that a varied number of somites are asymmetrical, i. e., there are somites with an elytron on one side and a cirrus on the other. For instance, in specimens A and B there was the same characteristic alternation on the last five somites furnished with these structures. It should be observed, however, that while in specimen A the alternation began on somite LXVIII, in specimen B it did not begin before somite LXXV. In specimen C, the alternation began as far anteriorly as on somite XXXIV and it ended on somite LI, each one of the hindmost somites being furnished with either two elytra or two cirri. The elytra, generally speaking, decrease gradually in size posteriorly; those of somites II and III, however, are frequently somewhat smaller than those of somite IV. Their shape varies not only from somite to somite but also in different specimens. Most of them are suborbicular, as a rule, sometimes somewhat extended on one side; the first of them may be irregularly suborbicular to subovoidal; the second is often subreniform to subovoidal. Their margin is frequently somewhat undulating; their surface is nearly smooth, and there are no "cilia". The color is usually milky white, entirely immaculate; or "more rarely with a central black spot or flecks of black, or with a black border on posterior edge" (Johnson, 1897, p. 176). Only one of the specimens examined by me had central spots developed, and these were restricted to the anterior half of the body. This specimen was found in the mantle cavity of a Cryptochiton from Monterey Bay.

*Distribution and Biology:* Grube's type specimen of *Polynoë vittata* was recorded from Alaska; a host was not mentioned. Baird's type of *Lepidonotus lordi* was taken from *Fissurella cratitia*, Vancouver Island. *Arctonoë lia* Chamberlin was described from a specimen taken in 2-3 fathoms, sandy bottom, in the vicinity of Port Clarence, Alaska. Johnson (1897, 1901) reported *Polynoë lordi* with Fissurellidae, *Cryptochiton*, and *Dermasterias imbricata*, from central California to Puget Sound, Washington. Moore's (1908) record is based on specimens from the starfish Luidia, Nanaimo, B. C., in 12 fathoms. Berkeley (1923) added *Thelepus plagiostoma* to the list of hosts, from Nanaimo, B. C. Okuda (1936) reported this species as taken in northern Japan with *Asterias amurensis*, *Haliotis kamtchatkana*, and *Patelloida sp.* Treadwell (1923, p. 4) reported *Polynoë lordi* even as far to the south as at Pichilinque Bay, Lower California. Even if the last identification should prove to be erroneous, it is evident from these data that the species has a wide range throughout the northern Pacific Ocean. Furthermore, it is probably an obligate commensal, but at the same time seems to have a very great tolerance in regard to choice of host.

*Systematic Discussion:* The species has a fairly extensive synonymy, due to a large extent to the various generic designations it has received. It is an excellent illustration of the confusion which has prevailed in regard to the generic delimitations in this family. The specific confusion was caused mainly by the fact that this form is characterized by quite different color phases. The confusion of genera may be briefly exemplified as follows. Grube (1855) re-

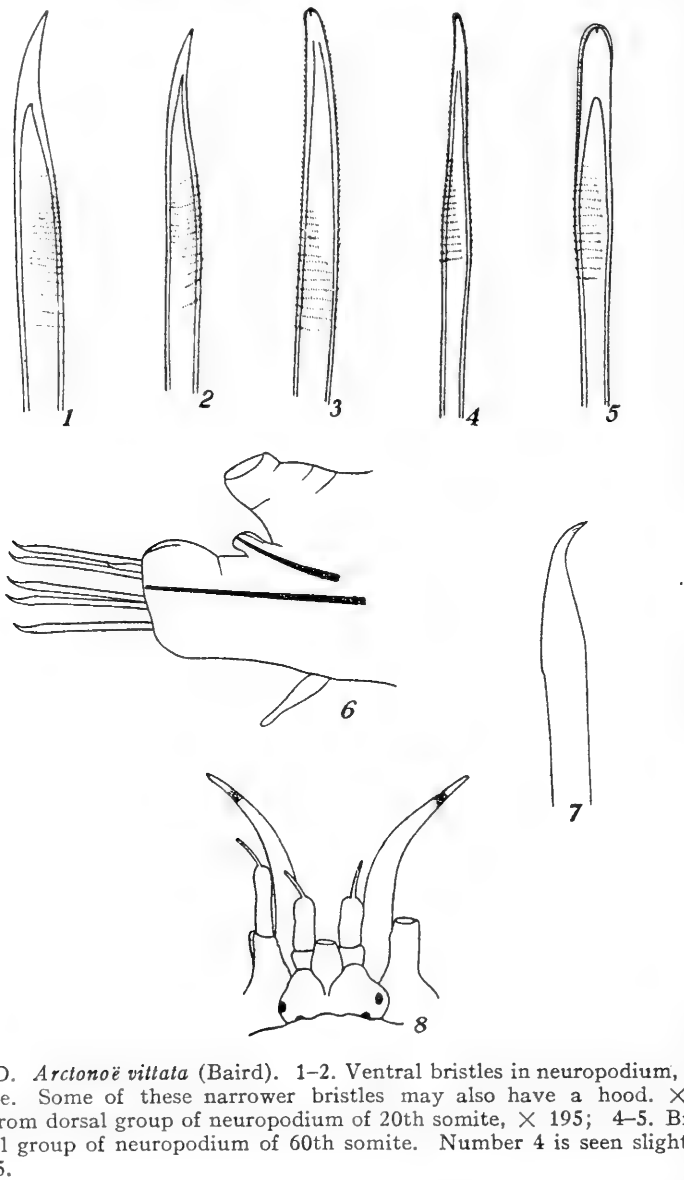


Figure D. *Arctonoë vittata* (Baird). 1–2. Ventral bristles in neuropodium, about 20th somite. Some of these narrower bristles may also have a hood. × 195; 3. Bristle from dorsal group of neuropodium of 20th somite, × 195; 4–5. Bristles from dorsal group of neuropodium of 60th somite. Number 4 is seen slightly on edge × 195.

*Arctonoë pulchra* (Johnson). 6. Parapodium of right 20th somite. 7. One of the ventral bristles of neuropodium of somite 21, × 75. Pectinae too small to be drawn. 8. Dorsal aspect of anterior end of body, × 8.

ferred his new species *vittata* to *Polynoë*, while Baird (1863) referred it (under the name of *lordi*) to *Lepidonotus*. When, two years later, Baird realized that *vittata* and *lordi* were identical, he assigned the species to *Halosydna*. Later Marenzeller (1902) transferred it to *Acholoë*, while a few years before Johnson (1897) had reëstablished it in *Polynoë*. Finally, Chamberlin (1920) assigned it to a new genus, *Arctonoë*, under the specific name of *lia*. His description and figures agree well with those for specimens from California which had been designated as *Polynoë lordi* by Johnson (1897). *Arctonoë* was separated from *Halosydna* primarily because its notopodial setae were bidentate, a very trivial feature from the viewpoint of generic distinction. Much more fundamental differences, of course, are to be found, *e. g.*, that the number of setigerous somites in *Halosydna* is constant from an early developmental stage, a character probably correlated with the fact that the anus shifts dorsally to one of the last segments in front of the pygidium, while in *Arctonoë* the number of segments apparently continues to increase throughout life, a feature connected with the peculiarity that the anus has maintained its original position on the pygidium, thus behind the teloblasts. Chamberlin (1920) did not compare his *lia* with either Grube's or Baird's species, but he referred *Lepidonotus fragilis* to his new genus. It is interesting to note in this connection that Chamberlin cited *Halosydna lordi* two pages farther on in the same article without any comment.

The description and figures of *Halosydna succiniseta* Hamilton, based on specimens from Laguna Beach, California, agree fairly well with those for *Arctonoë vittata*. The character of the so-called collar on the notosetae was based on a single specimen. A bristle of this kind, from a specimen of *A. vittata* taken in Monterey Bay, is shown in text figure C, 26. My identification is, however, in part based on the assumption that Hamilton's data are presented in a very superficial manner, and that as a consequence comparisons must be made *cum grano salis*. Compare, for instance, the prostomium as figured by Hamilton (1915, Fig. 3) and by me. Hamilton stated that *Halosydna succiniseta* "closely resembles *H. lordi*."

### **Arctonoë pulchra** (Johnson)

Text figure D, 6–8

*Polynoë pulchra*, JOHNSON, 1897, p. 177; 1901, p. 390.
*Halosydna pulchra*, MOORE, 1908, p. 329; 1909, p. 240; 1910, p. 328; TREADWELL, 1914, p. 179; BERKELEY, 1923, p. 212.
*Halosydna leioseta*, CHAMBERLIN, 1919, p. 2.
*Halosydnoides vittata*, (GRUBE) var. *pulchra*, SEIDLER, 1924, p. 136.

*Description:* The longest specimen measured by me was 70 mm in length, exclusive of prostomial appendages. This Monterey Bay specimen thus was considerably longer than the longest specimen from the same bay taken by Johnson (1897); his longest specimen measured only 51 mm. Ratio between length and width (between tips of parapodia, exclusive of bristles) of body, about 5.0–6.4:1. Usual number of somites recorded by me was 48 to 70, exclusive of pygidium. Dorsum usually exposed along the middle, but not quite so broadly as in *A. vittata;* the middle portion o prostomium usually uncovered; and the anus is not covered.

Prostomium always somewhat wider than long but otherwise is variable in shape; sometimes its sides are fairly evenly rounded, sometimes they are more or less irregular, due to the presence of two similar lateral expansions at or behind the middle, and sometimes the two sides are somewhat different mutually in this respect. It is always two-lobed. The two lobes are separated anteriorly by the ceratophore of the median tentacle; posteriorly they may be separated by a shallow groove, or they may merge completely; anteriorly they are either truncate or more or less rounded. The two pairs of eyes are moderate and subequal in size. Ceratophores of the lateral tentacles are comparatively large and thick, about as long as wide or even somewhat shorter relatively. Lateral tentacles short and stubby; when contracted, they are about 2.0–3.5 times longer than the ceratophore and about 1.5–2.5 times longer than wide; their filamentous tips may be somewhat longer than the tentacles proper, but usually they are somewhat shorter. Ceratophore of the median tentacle, which begins at or somewhat in front of the middle of the prostomium (its posterior extension is frequently not possible to establish with certainty), is truncate anteriorly, and either subobovate or, and this seems to be the rule, subpentagonal. Median tentacle of about the same shape and structure as the lateral ones and either about as long as, or slightly longer than these; in other words, it is, exclusive of the distal filamentous appendage, about as long as or somewhat shorter than prostomium. Its filamentous appendage sometimes is a little shorter than those of the lateral tentacles. Prostomium and its appendages whitish, without distinct pigment cells.

The palpi, which are whitish with a dark cross band near the tip, are fairly thick at the base, taper gradually to a fine point, and are about 3–4 times longer than the median tentacle exclusive of its filamentous appendage.

The two cirri of the uniramous first parapodium are either subequal or the ventral one is slightly the shorter. Dorsal cirri present whenever elytra are not developed. Cirrophores of moderate size or rather large; usually they are subcylindrical, tapering somewhat distally; sometimes they are more or less swollen at the base. Cirrophores, as well as the dorsal and ventral cirri, are whitish.

Notopodium small (from about $\frac{1}{6}$ to much less of the length of the neuropodium), rounded verruciform, and somewhat elongated. The one of the second somite usually has a varying number (about 4-10) of very short setae near the base (Johnson, 1897, pl. 8, fig. 50b). The ones of somites III–VI either lack bristles or have only a few short ones. The remaining notopodia seem always to lack bristles. The neuropodia, which are more or less truncate distally and somewhat longer to somewhat shorter than thick, have a small number of bristles. According to Johnson (1897, p. 177), the number varies from 6 to 12; I have found 4–6 to be the usual number and the total range to be 3–9; in the last few somites only 2–3 bristles are found. The size of the bristles also gradually decreases posteriorly. All the bristles are of the same type, somewhat hooked distally with a quite sharp point. The only difference which we have found lies in the thickness of the bristles, and in some specimens all the bristles of each parapodium may have approximately the same thickness. The degree of curvature near the tip may be either somewhat more or somewhat less pronounced than in the figure of the neuropodial bristle given in this paper. The pectinae, located on the thickened portion of the bristle some distance from the tip, are moderate in number (about 8–15), or rather few, and they are so fine that they could not be shown in the appended figure without very decided exaggeration (Johnson, 1897, pl. 8, fig. 50a). Usually the bristles are about as long as or somewhat longer than the distal width of the neuropodium.

The typical pre-elytrophores are rather small and verruciform; some of the anterior ones are fairly large and mammilliform.

The nephridia open, in most segments, on very small, rounded papillae, which frequently are too minute to allow a certain statement as to on which somites they are present. However, the papillae certainly are absent from some of the anterior and from some of the posterior somites. According to Johnson (1897), the dorsum is "transversely marked with brown bands, two to each somite". In the specimens examined by me the dorsum lacked pigmentation.

The elytra, which are deciduous, i. e., they fall off readily in preserved specimens, had in one specimen a very regular arrangement behind somite XXXIII, being always paired and present on every other somite: on XXXV, XXXVII, etc. In another specimen, the same regularity was established to somite LIV, inclusive; then followed three somites with paired elytra, viz., LV, LVI, and LVII; LVIII had cirri; LIX and LX had paired elytra; and from that segment on there occurred a regular alternation of paired elytra and cirri.

In regard to the shape, structure, and pigmentation of the elytra, I found Johnson's (1897, p. 177) information correct. "Elytra slightly undulate at margin, broadly reniform, adorned with a black or dark brown spot over the elytrophore, and a narrow posterior border of the same color . . . very smooth." I did not find any "immaculate" specimens in Monterey Bay. It may be noted that Moore (1908) sometimes found the dorsum to be poppy red.

*Distribution:* Alaska south to San Diego, California. Occurs usually in the littoral or sublittoral, but Moore (1910) recorded it off Santa Catalina, southern California, from a depth of 162 fathoms.

*Biology:* Like *A. vittata*, this species appears to be an obligate commensal with a remarkable tolerance in regard to choice of hosts. The following host relationships have been observed:

*A. pulchra*—

*Stichopus californica*—sea cucumber..........Pacific Grove, Calif. (Johnson)
*Megathura crenulata*—keyhole limpet

*Solaster decemradiata*—starfish..................Washington; Alaska (Moore)
*Cryptochiton stelleri*................................Monterey, Calif. (Moore)
Sea Urchin...................................Laguna Beach, Calif. (Moore)

*Asterias*—starfish..............................Nanaimo, B. C. (Berkeley)
*Solaster stimpsoni*—starfish
*Pteraster tesselatus*—starfish
*Luidia*—starfish
*Stichopus*—sea cucumber

Systematic Discussion: *Halosydna leioseta* Chamberlin (1919, pp. 2–3), taken at Laguna Beach, California, was described as a commensal with a sea urchin. The description does not diverge from that of *A. pulchra* except that Chamberlin describes the color, after preservation, as grayish with no definite markings. Judging by the variability in the coloration of related species, this single feature should not be accepted as sufficient for specific differentiation.

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## PLATE 43

*Halosydna brevisetosa* Kinberg

Fig. 1. Dorsal aspect of anterior part of body after removal of elytra, × 6.

Fig. 2. Same, view of posterior part of body, × 6.

Fig. 3. Anterior end of body in ventral view with inverted proboscis, × 6.

Fig. 4. Anterior part of body in dorsal view with the proboscis everted. × 6.

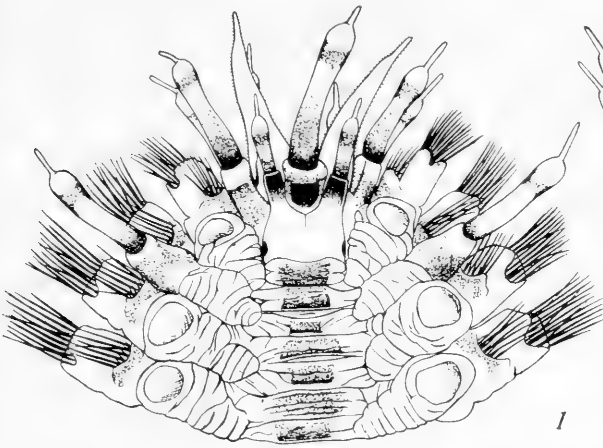
Fig. 5. Dorsal view of prostomium; tentacles cut off, × 16.

Fig. 6. Dorsal view of prostomium with intact tentacles, × 10.

Fig. 7. Mouth, open, × 11.

Fig. 8. Mouth, closed, × 10.

In all the figures, the dots indicated the density of the pigmentation.



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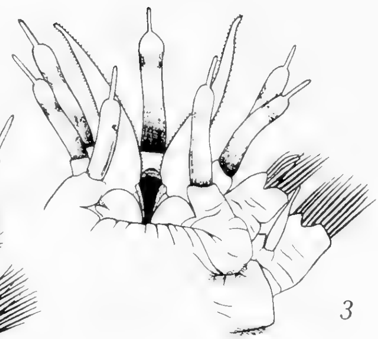

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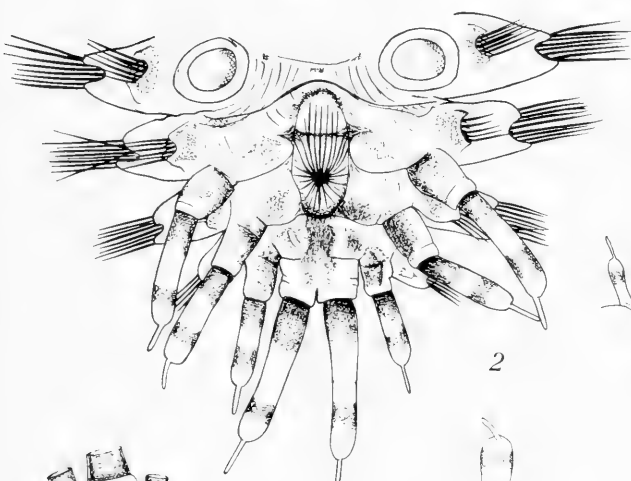

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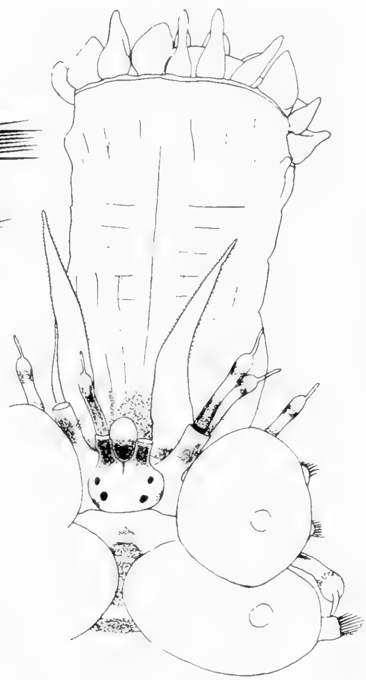

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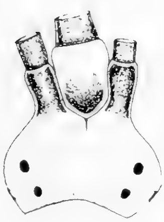

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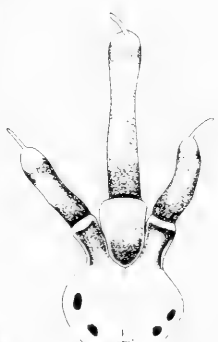

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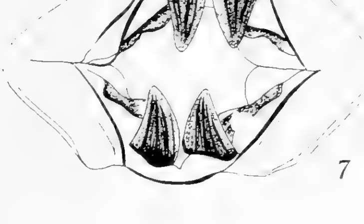

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**PROCEEDINGS**

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## No. 34

# REEF CORALS FROM THE CALIFORNIA MIDDLE EOCENE*

BY

J. WYATT DURHAM

Recently a number of reef corals were turned over to the writer by Dr. G. D. Hanna for examination and description. Most of the species were found at Calif. Acad. Sci. Loc. 30667 (from basal *Spiroglyphus* sands, Domengine Reef, S. W. corner Sec. 27 through N. E. ¼ of S. E. ¼ of Sec. 28, T. 28 S., R. 19 E., Mt. Diablo Base and Meridian, south side of headwaters of Media Agua Creek, Kern County, Calif.), but two were from Loc. 30667A (from top of ridge ¼ mi. N. W. of 30667, in a black pebble conglomerate). A single specimen, which is identical with a species from Loc. 30667 (C. A. S.), was from Loc. 1692 (N. W. ¼ of Sec. 11, T. 7 N., R. 24 W., San Bernardino Base and Meridian).

Because of better preservation this specimen has been made the holotype of the species *Leptastrea hertleini* Durham, n. sp. No further discussion of this species from Loc. 1692 will be made; all notes refer to its occurrence at Loc. 30667.

At Loc. 30667 and 30667A (apparently about the same horizon) the corals were found weathered out on the ground. Other fossils found include *Turritella lawsoni* Dickerson, *Spiroglyphus* n. sp. (not *S. tejonensis*), *Campanile* n. sp. and *Discocyclina* sp. (very thin). Some *Discocyclina* were adhering to the corals, so that there is no doubt as to the corals belonging with the middle Eocene fauna.

The material examined includes eight identifiable species, all but one (*Astreopora sanjuanensis* Durham) being new. The genera in-

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clude: *Astreopora*, *Astrocoenia*, *Coeloria*, *Favia*, *Leptastrea*, *Oulophyllia*, *Podasteria* (*Manicina* of authors) and *Stylophora*. With the exception of *Astreopora* none of these genera have previously been reported from the Pacific Coast Tertiary. (Species of *Astrocoenia* and *Favia* have been described, but were later referred to other genera.) The recent distribution of these genera is as follows:

*Astreopora:* Red Sea, Indian Ocean, Australia, Solomon Islands.
*Astrocoenia:* Atlantic.
*Coeloria:* Restricted to Indo-Pacific.
*Favia:* Atlantic and Indo-Pacific.
*Leptastrea:* Red Sea, Indo-Pacific.
*Oulophyllia:* Indo-Pacific.
*Podasteria:* Atlantic, Caribbean.
*Stylophora:* Red Sea, Indo-Pacific.

From the above list it may be seen that the fauna as represented by these genera has its greatest affinities with the recent Indo-Pacific faunas although there are two definite Atlantic-Caribbean elements in it. This may be contrasted with the conclusion of Vaughan (1917, U. S. Geol. Surv. Prof. Paper 98, p. 367) on the late Miocene or early Pliocene reef coral fauna of Carrizo creek, California, which has its greatest affinities with the recent Caribbean fauna. However, it agrees with his conclusion that the earlier Tertiary faunas contained representatives of 3 recent faunal provinces.

All of these genera are typically reef dwellers, living in shallow tropical seas. At the present time reef corals are not found farther north on the Pacific Coast than Guaymas in the Gulf of California. It therefore appears that this coral fauna would have its modern ecological equivalent at least as far south as Guaymas. In view of the occurrence of reef corals in strata of approximately the same age in northern Washington (about 15 degrees farther north), it is likely that the actual equivalents would be well within the tropics, rather than in the subtropics.

According to Vaughan (1919, Annual Report Smithsonian Inst. for 1917, p. 197) massive reef building corals are largely found in waters 37 meters or less in depth, with a few species extending down to 48 meters. It appears probable therefore that this fauna lived in waters of 37 meters or less depth, for associated with it is *Discocyclina* and the large gastropod *Campanile*, both of which are typically reef or shallow water inhabitants.

### **Astreopora** de Blainville

*Astreopora* de Blainville, 1830, Dict. Sci. Nat., vol. LX, p. 348.
Genotype: *Astraea myriopthalma* Lamarck (1816).

### **Astreopora sanjuanensis** Durham

*Astreopora sanjuanensis* Durham, 1942, Journ. Paleo., vol. 16, No. 1, p. 102, pl. 15, fig. 20; pl. 16, fig. 9.

The specimens at hand vary somewhat from the holotype of this species which comes from the Crescent formation of Washington, but their range of variation includes that found in the type. One specimen is 70 mm. high by nearly 60 mm. in its greatest diameter. Many calices are 2.5 mm. in diameter, but some are around 1.5 mm. which size approximates that on the Washington specimen. The septa are thin and have the same pattern but in some corallites extend closer to the center of the calice.

Hypotype: No. 5908 (Calif. Acad. Sci., Paleo. Type Coll.), from **Loc. 30667** (C. A. S.).

The species is found in Washington in beds correlated by Berthiaume (1938, Journ. Paleo., vol. 12, p. 495) with the Capay of California.

### **Astrocoenia** Milne Edwards and Haime

*Astrocoenia* Milne Edwards and Haime, 1848. Compt. Rend. Acad. Sci., Paris, t. XXVII, p. 469.
Genotype (monotypic): *Astraea numisma* Defrance (1826).

### **Astrocoenia dilloni** Durham, new species

Plate 44, fig. 3

Corallum small, 10 by 18 mm., subplanate. Calices small, from 1.3 to 2.5 mm. in diameter, maximum depth 0.5 mm. Maximum thickness of thecal wall 0.4 mm., between adjacent calicular cavities, usually less. Ten prominent septa reach columella, a smaller septum between each pair apparently not reaching columella. Major septa fused to the sunken styliform columella which is usually about one-fourth the diameter of the calice. Major septa with about five poorly defined denticles. Septal faces granulate.

*Holotype:* No. 7724 (Calif. Acad. Sci., Paleo. Type Coll.), from **Loc. 30667A** (C. A. S.).

This species may be distinguished from other American *Astrocoenias* by the 10 major septa.

## **Coeloria** Milne Edwards and Haime

*Coeloria* Milne Edwards and Haime, 1848. Compt. Rend. Acad. Sci., Paris, t. XXVII, p. 493.

Genotype (monotypic): *Madrepora daedalea* Ellis and Solander 1786, *non* Forskål 1775 (see Wells, 1936, Am. Journ. Sci., vol. XXXI, p. 104).

### **Coeloria wellsi** Durham, new species

Plate 44, figs. 2, 13, 14

Corallum massive, explanate. Valleys usually short and separate, 5 to 8 mm. wide, up to 20 mm. long, averaging around 10 mm. long, 1 to 3 mm. deep. Collines narrow and sharp. Septa about 20 to centimeter, alternates usually incipient only, extending up and across colline but worn at top. Septal denticulations fine. Septa in some valleys as thick as their interspaces but in others considerably thinner. Columella small, trabecular.

*Holotype:* No. 5914 (Calif. Acad. Sci., Paleo. Type Coll.), from **Loc. 30667** (C. A. S.).

The general form of the corallum and separate valleys closely resembles the recent Coelorias but the closely set septa readily distinguish it.

## **Favia** Oken

*Favia* Oken, 1815, Lehrb. Naturgesch, Th. 3, Abt. 1, p. 67.

Genotype: *Madrepora fragum* Esper (1795).

### **Favia hannai** Durham, new species

Plate 44, figs. 9, 10, 11

Corallum massive, upper surface convex, 45 mm. in diameter, 25 mm. high, attached by pedicel. Corallites distinct, irregular in shape, and separated from 2 to 5 mm., usually 3. Calices up to 3 mm. deep, a slightly raised edge. Costae corresponding to septa, extending out into intercalicular area 1 to 2 mm. Septa thin, 25 to 30 to a mm., alternate septa thicker. Septal denticulations 2 or 3 to a mm., rounded. Columellar area small, apparently formed by trabecular fusion of inner ends of major septa.

*Holotype:* No. 7730, paratypes Nos. 7731, 7776 (Calif. Acad. Sci., Paleo. Type Coll.), Univ. Calif. Mus. Paleo. No. 30641, from **Loc. 30667** (C. A. S.).

This species is not closely allied to any known to the author. The septa are much closer together and thinner than those of any available description.

One poorly preserved specimen has a diameter of 10 centimeters.

### **Leptastrea** Milne Edwards and Haime

*Leptastrea* Milne Edwards and Haime, 1848. Compt. Rend. Acad. Sci., Paris, t. XXVII, p. 494.
Genotype: *Leptastrea roissyana* Milne Edwards and Haime (1850).

### **Leptastrea hertleini** Durham, new species

Plate 44, figs. 1, 4, 5

Corallum massive, flattened, more or less eroded. Holotype 87 x 52 x 33 mm. Intercorallite furrows indeterminate, corallites not projecting. Peritheca dense. Calices rounded, 2 to 3 mm. in diameter, usually about 0.5 mm. deep to top of columella. Septa in three cycles, swollen in theca, becoming thinner towards columella. Third cycle not always reaching columella. Septa two-thirds as thick as interspaces next the wall, primaries thickest. In cross section columella one-third to one-half the diameter of corallite, projecting slightly above bottom of calice. Septa not continuous from one calice to next, apparently not exsert.

*Holotype:* No. **5911** (Calif. Acad. Sci., Paleo. Type Coll.), from **Loc. 1692** (C. A. S.).

Paratype No. **5913** occurs at loc. 30667 (C. A. S.) but the specimen is poorly preserved. It seems to have slightly deeper calices than the holotype, but it is partially recrystallized. Because of the poor preservation it cannot be determined whether the differences are real or due to weathering.

No comparable species is known as yet from the Pacific Coast Tertiaries.

### **Oulophyllia** Milne Edwards and Haime

*Oulophyllia* Milne Edwards and Haime, 1848. Compt. Rend. Acad. Sci., Paris, t. XXVII, p. 492.
Genotype (monotypic): *Meandrina crispa* Lamarck (1816).

### **Oulophyllia californica** Durham, new species

Plate 44, figs. 7, 12

Corallum 55 mm. in diameter, about 25 mm. high, broadly pedicelate. Valleys 5 to 14 mm. wide, up to 5 mm. deep, distinct calicinal centers. Collines thin and narrow above, not grooved. Septa thin, about 16 to a centimeter, every alternate one heavier and reaching columella. Upper half of principal septa narrow, lower half broad. Septal denticulations apparently coarse. Columella distinct, trabecular, 1.5 mm. to 2 mm. in diameter. Fine costae, about 20 to a centimeter, on external surface.

*Holotype:* No. 5918 (Calif. Acad. Sci., Paleo. Type Coll.), from **Loc. 30667** (C. A. S.).

The holotype generally resembles the recent *O. crispa* (Lamarck), but the latter species has only 9 to 10 septa to the centimeter.

## **Podasteria** Ehrenberg

*Podasteria* Ehrenberg, 1834; Corallenth., des Rothenmeeres, p. 326.
Genotype (monotypic): *Manicina gyrosa* Ehrenberg 1834. = *Podasteria mayori* Wells 1936. *non Madrepora gyrosa* Ellis and Solander 1786, pl. 51, fig. 2. (See Wells, 1936, Am. Journ. Sci., vol. XXXI, p. 125).

## **Podasteria churchi** Durham, new species

Plate 44, fig. 6

Corallum small, nearly explanate, nearly 45 mm. in diameter. Lower surface with broad pedicel, no calices. Colline somewhat variable, at times moderately wide and grooved, at others rather narrow and sharp with no trace of groove. Valleys irregular, broad, of varying width, from 4 to 12 mm. wide, up to 3 mm. deep. Septa thin, about 20 to a centimeter. Alternate septa may be less prominent than rest. Septal denticulations nearly 3 to a mm. Columella trabecular, from 0.8 to 1.7 mm. wide. Presence or absence of costae indeterminate on holotype.

*Holotype:* No. 7725 (Calif. Acad. Sci., Paleo. Type Coll.), paratype No. 5917 from **Loc. 30667** (C. A. S.).

This species resembles the recent *P. areolata* (Linnaeus) but differs from it in the slightly greater number of septa to a centimeter and the lesser depth of the valleys.

## **Stylophora** Schweigger

*Stylophora* Schweigger, 1819 (part). Beobacht, Naturhistor-Reisen, Tab. 5.
Genotype: *Madrepora pistillata* Esper. (1797).

**Stylophora chaneyi** Durham, new species

Plate 44, fig. 8

Corallum ramose, a small fragment, 14 mm. high, 5 to 6 mm. in diameter except near points of bifurcation where it is greater. Calices from 0.8 mm. to 1.0 mm. in diameter, distant 0.2 to 0.5 mm. from one another. No apparent projecting upper lip. Septa in two cycles, primaries reaching columella which is usually slightly elongated in direction of two directive septa. Directive septa usually slightly more prominent than remainder. Septa of second cycle not as prominent, reaching from one-third to one-half distance to columella. Septa about one-half as wide as septal inter-spaces. Upper edges of septa apparently entire. Columella styliform, not projecting above calicular surface, but extending up about one-half depth of calice from top of primary septa. Coenenchymal surface granulate.

*Holotype:* No. 7723 (Calif. Acad. Sci., Paleo. Type Coll.), from **Loc. 30667** (C. A. S.).

This species appears to be close to *S. canalis* Vaughan (1919), but may be distinguished by its more compact coenenchyma.

## PLATE 44

Fig. 1. *Leptastrea hertleini* Durham, new species, × 3.1. Cross section of corallites. Holotype No. 5911 (Calif. Acad. Sci., Paleo. Type Coll.), from Loc. 1692 (C. A. S.).

Fig. 2. *Coeloria wellsi* Durham, new species, × 0.47. Holotype No. 5914 (Calif. Acad. Sci., Paleo. Type Coll.), from Loc. 30667 (C. A. S.).

Fig. 3. *Astrocoenia dilloni* Durham, new species, × 1.9. Holotype No. 7724 (Calif. Acad. Sci., Paleo. Type Coll.), from Loc. 30667A (C. A. S.).

Fig. 4. *Leptastrea hertleini* Durham, new species, × 0.48. Holotype (same specimen as fig. 1).

Fig. 5. *Leptastrea hertleini* Durham, new species, × 2.4. View of calices (same specimen as fig. 1).

Fig. 6. *Podasteria churchi* Durham, new species, × 1.0. Holotype No. 7725 (Calif. Acad. Sci., Paleo. Type Coll.), from Loc. 30667 (C. A. S.).

Fig. 7. *Oulophyllia californica* Durham, new species, × 0.5. Holotype No. 5918 (Calif. Acad. Sci., Paleo. Type Coll.), from Loc. 30667 (C. A. S.).

Fig. 8. *Stylophora chaneyi* Durham, new species, × 1.9. Holotype No. 7723 (Calif. Acad. Sci., Paleo. Type Coll.), from Loc. 30667A (C. A. S.).

Fig. 9. *Favia hannai* Durham, new species, × 0.51. Holotype No. 7730 (Calif. Acad. Sci., Paleo. Type Coll.), from Loc. 30667 (C. A. S.).

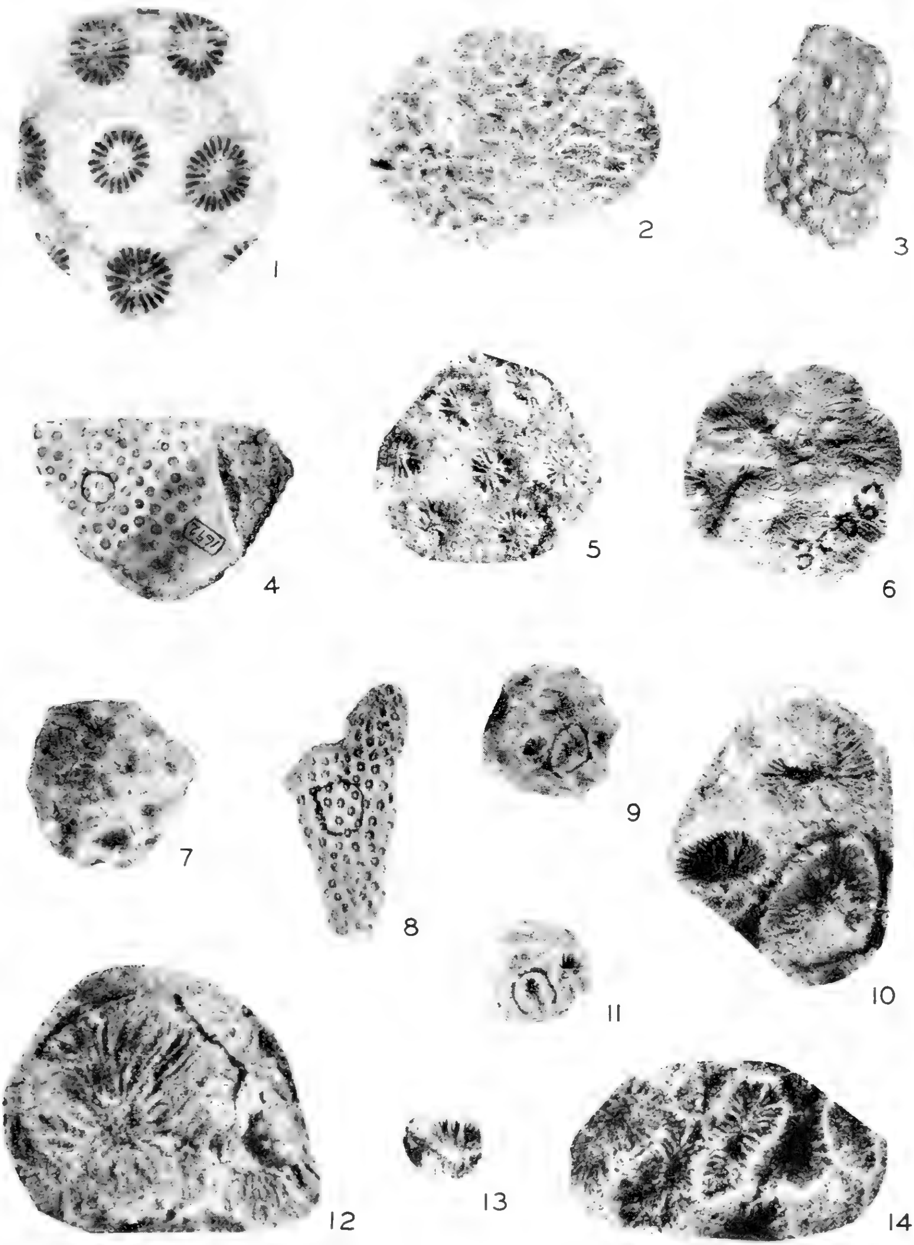
Fig. 10. *Favia hannai* Durham, new species, × 1.6. Detail of calices (same specimen as fig. 9).

Fig. 11. *Favia hannai* Durham, new species, × 0.51. Paratype No. 7731 (Calif. Acad. Sci., Paleo. Type Coll.), from Loc. 30667 (C. A. S.).

Fig. 12. *Oulophyllia californica* Durham, new species, × 2.2. Detail of a calice (same specimen as fig. 7).

Fig. 13. *Coeloria wellsi* Durham, new species, × 1.3. Detail of part of a calice showing incipient septa (same specimen as fig. 2).

Fig. 14. *Coeloria wellsi* Durham, new species, × 1.3. Detail of another calice (same specimen as fig. 2).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**No. 35**

# MAMMALS OF THE CLEARWATER MOUNTAINS, IDAHO

BY

ROBERT T. ORR
*Assistant Curator, Department of Ornithology and Mammalogy*

## Introduction

The Rocky Mountains of northern United States are of great biological interest as a region in which a mixture of Pacific coastal and true Rocky Mountain plants and animals occurs. This condition is in all probability a result of several critical factors, among which may be suggested the proximity of the inland range to the Pacific Ocean at this point as compared with the same mountain mass farther to the south, the more northerly latitude, the absence of high coastal mountains in extreme southern British Columbia and also the absence of high mountain masses in eastern Washington. As a consequence the coastal influence with its relatively high humidity and high annual precipitation extends inland to northern Idaho and extreme northwestern Montana.

Relatively little of a general nature has been published regarding the mammals of this region and even less of a detailed nature concerning its mammalian fauna. This paucity of information was mentioned by Davis (1939) in his admirable work summarizing all the known data on the mammalian fauna of the state of Idaho. It was with the purpose of furthering our knowledge of the distribution of mammals in central Idaho that an expedition was sent by the California Academy of Sciences, in the fall of 1941, to the region of the Middle Fork of the Clearwater River in Idaho County. The personnel of the party comprised Dr. G. Dallas Hanna, Curator of

Paleontology, Mr. Cecil Tose, Department of Exhibits, Mr. Anatole Loukashkin, Research Associate in Ornithology and Mammalogy, and the author.

It had originally been planned to collect in the Crags Mountains region which is situated between the Lochsa and Selway forks of the middle branch of the Clearwater River. Excessive rains, however made the roads in that region impassable for the most part and necessitated a change in plan. As a result, most of the field work was done in a portion of the Selway Fork drainage, principally in the canyon through which Meadow Creek flows and the ridges leading down to this north-flowing tributary of the Selway.

Two principal base camps were established. The first of these was situated along Meadow Creek, two miles south southeast of Selway Falls, at an elevation of 1,900 feet, between September 5 and 12. Activities here were confined principally to a study of riparian and lower canyon slope associations. The second camp, from September 12 to 30, was located on a ridge four miles southwest of Selway Falls, at 5,800 feet elevation, where opportunity was afforded to collect and observe mammals occurring on the tops and upper slopes of ridges. The second camp proved considerably more productive so far as mammal collecting was concerned. A one day trip was made to the Crags Mountains. The excessive rain and occasional snow, which occurred intermittently during all but five of the days the party was in Idaho, interfered to a considerable extent with collecting and especially with the drying of material secured.

While the primary purpose of the expedition was to secure mammals and land snails from this region, a number of birds, insects, and botanical specimens were also collected. Furthermore, considerable attention was paid to the natural history of the various species of mammals encountered, in so far as was possible. In all a total of 251 mammal specimens was secured. These represented 25 different species. The presence of 15 additional species, however, is here recorded, based either on personal observations made by members of the party or on the reports of other persons known to be reliable and accurate observers.

The writer wishes gratefully to acknowledge assistance received from Mr. John Thomas Howell of the Department of Botany of the California Academy of Sciences who kindly identified many of the plants collected, also Mr. Ralph L. Hand of the United States Forest Service, Missoula, Montana, who furnished the writer with information concerning previous forest fire records for the region studied as well as personal notes on the occurrence and distribution of certain species of mammals in the Clearwater Mountains. For the privilege of examining certain comparative material necessary to complete this report the writer is indebted to the University of California Museum of Vertebrate Zoology. The cooperation of the Idaho Department of Fish and Game was greatly appreciated.

*Description of Area*

The Clearwater River, which drains approximately 8,000 square miles of territory in east-central Idaho, has its headwaters principally along the western slopes of the Bitterroot Mountains, whose summit roughly constitutes the boundary between the states of Idaho and Montana in this section. The upper portion of the river is separated into three principal forks which converge in west-central Idaho to form the main Clearwater; the latter flows in a westerly direction and empties into the Snake River along the Idaho-Washington boundary in the vicinity of Lewiston, Idaho.

The so-called Clearwater Mountains area is, to quote Lindgren (1904, p. 59) " . . . an elevated plateau, of approximately uniform height, now so deeply dissected by such an intricate system of canyons that at first glance it has almost lost its once doubtless prominent plateau features." The average altitude of the ridges and peaks forming this mountain mass varies from 6,000 to 7,000 feet. Little evidence of glaciation is apparent except on the tops of some of the higher mountains. As a consequence of long periods of erosion the canyons are characteristically very deep, and broad valleys are absent. The average vertical distance between the summits of the ridges and the canyon bottoms is around 4,000 feet. This is in marked contrast to the Bitterroot Mountains, which adjoin the Clearwaters to the east, where we find evidence of the most extensive glaciation found in the entire Rocky Mountains of the United States.

According to Dr. G. Dallas Hanna, geologist and paleontologist with the expedition, in the immediate vicinity of Kooskia, which is about thirty-three miles west of Selway Falls on the lower, western slope of the Clearwater Mountains, the surface is covered by dark colored lavas of undetermined source and thickness. A few miles up the Clearwater River this type of rock is in contact with light colored gneiss which forms the mountain ranges to the eastward as far as the collecting party went. Much of the gneiss shows irregular banding and often has a granitoid texture.

Evidence of mountain glaciers was obvious on the upper slopes of the Crags Mountains. Morainal material and U-shaped valleys were common and in some places it seemed that the ice had recently disappeared. None of the usual evidences used for determining the previous presence of glaciers was observed on the lower slopes of these mountains or in those parts of the surrounding Clearwater Mountains where most of the collecting was done.

Dr. E. C. Van Dyke (1919, p. 1-12) many years ago came to the conclusion from a study of ground beetles, that much of the mountainous area of Idaho had long been undisturbed from a biological standpoint and, at his special request, careful search was made for evidence of glaciation. If, here, a large region continued through the Pleistocene without denudation, the presence of a relatively isolated insect fauna would be more easily explained. The observations made on the routes followed by one party certainly bears out his deduction. Furthermore, there exists in this region a most striking land snail fauna, the affinities of which are now difficult to trace. Unusual distribution among other groups of animals and plants has been noted. Thus, this region has a definite insular character from a biological standpoint, which, with the absence of evidence of general glaciation, leads to the belief that some of the elements of the fauna and flora may have lived through the Pleistocene without major disturbance.

Climatically, the Clearwater Mountains are characterized by relatively high precipitation compared with other portions of the State. No data were available for the exact area where collecting and observations were made, but in the Climatic Summary of the United States, Section 5—Northern Idaho, published by the United States Department of Agriculture Weather Bureau, the average annual precipitation up to the close of the year 1930 for the Pete King Ranger Station was 33.80 inches. This locality is at an elevation of 1,550 feet on the Lochsa Fork of the Middle Clearwater, several miles above its junction with the Selway Fork and is approximately fifteen miles west northwest of Selway Falls. Undoubtedly the precipitation is considerably greater in the latter locality which is closer to the center of the mountain mass. Farther north in the Clearwater Mountains, at Oxford Ranger Station in Clearwater County, at an elevation of 3,735 feet, the average annual precipitation to the close of the year 1922 is given as 45.77 inches. This locality, however, is within the watershed of the North Fork of the Clearwater.

Precipitation is well distributed over the year, although it is somewhat less in July and August than during the remaining months. In winter this precipitation is in the form of snow which is present from November until March. During September, 1941, several light snow falls occurred, sufficient to cover the tops of the higher ridges. Subsequent rain storms, however, soon melted the snow.

Summer rains and relatively high humidity combined with moderately cold winters are probably the direct factors inducing the growth of a vegetation complex composed of the more hardy species of the Pacific coastal forests and the northern Mesophytic evergreen forests of the west. This is well expressed by Livingston and Shreve, (1921, pp. 537–538) in regard to western hemlock (*Tsuga heterophylla*): "This tree occupies an area in which conditions are similar to those of the northwestern Evergreen Hygrophytic Forest, with differences due to the extension of the limits of *Tsuga* into northern Idaho and Montana, well to the east of the Hygrophytic Forest. The number of cold days in the frostless season endured by the easternmost individuals of this species reaches a maximum of 120, whereas no cold days are experienced within the Hygrophytic Forest. The normal daily mean temperature also ranges to lower values for the tree than for the vegetation in which it is most characteristically developed. The temperature conditions encountered by *Tsuga* in northern Idaho . . . are otherwise very similar to those in coastal Washington and Oregon. The precipitation conditions for the area occupied by *Tsuga* are very similar to those of the Hygrophytic Forest, at least with respect to the frostless season. Higher intensities of evaporation are encountered in Idaho . . . ."

The average temperature for the Pete King Ranger Station for the period from 1910 to 1930 inclusive, according to the United States Weather Bureau is 50.0° F. with the greatest extremes 112° F. and −30° F. The average maximum temperature throughout the year for this period is 62.1° F. and the average minimum temperature 37.8° F.

### *Habitats*

Although a considerable portion of the drainage of the Middle Fork of the Clearwater River was burned in previous years the area in which the present studies were carried on was for the most part virgin timber. A number of different forest associations were found to occur. Some of these were quite distinct while others differed principally with regard to the dominance of certain species of trees and shrubs which were common to several associations. This was found in certain instances to affect directly or indirectly the local distribution of some mammalian forms. Since collecting was carried on in the fall of the year most of the annual plants had disappeared and even many of the perennials had shed their leaves.

The following plant associations were conspicuous in the limited area studied. With the exception of brushland, which here was largely a result of fire and consequently not governed to any considerable extent by altitude, four other principal associations occurred from the canyon bottoms to the summits of the highest ridges. These may be described as (1) riparian, (2) fir, cedar and yew forest, (3) fir and spruce forest, (4) lodgepole pine forest, and (5) brushland.

*Riparian.*—The river banks and streamsides were, generally speaking, lacking in dense vegetation such as is usually characteristic of mountain watercourses. In several instances it appeared that beavers were responsible for the depletion of certain riparian vegetation, such as willow. The following species of plants were noted most commonly along watercourses in the bottoms of canyons:

| | |
|---|---|
| *Equisetum arvense* | *Alnus tenuifolia* |
| *Carex* sp. | *Boykinia major* |
| *Salix sitchensis* | *Philadelphus Lewisii* |
| *Salix* sp. | *Symphoricarpos albus* |

Only two species of mammals observed seemed restricted to watercourses and the immediately adjacent territory. These were beaver and mink. Several species of bats of the genus *Myotis* regularly foraged over waterways when available but they were by no means restricted to them. Where suitable grassland grew along stream banks such places proved attractive to meadow mice. White-tailed deer, while not strictly riparian inhabitants in this region, occurred principally in canyon bottoms where they undoubtedly foraged to a considerable extent on streamside growth.

*Fir, cedar and yew forest.*—In the deep canyon bottoms and lower slopes the dominant trees were western red cedar (*Thuja plicata*), grand fir (*Abies grandis*) and western yew (*Taxus brevifolia*). Farther up the slopes, locally, in more open and exposed situations, this forest was partly replaced by one composed principally of Douglas fir (*Pseudotsuga taxifolia*) and yellow pine (*Pinus ponderosa*) associated with such shrubs as snow berry (*Symphoricarpos albus*), service berry (*Amelanchier Cusickii*) and mountain ash (*Sorbus sitchensis*). This latter type of forest, however, failed to reach its maximum development here, whereas, on the lower, western slopes of the Clearwater Mountains it was found to be the dominant forest cover.

The fir, cedar and yew association was essentially one of shaded canyons or slopes and was characterized by a luxurious undergrowth of shrubs and herbs, numerous fungi and trees well covered with lichens. Locally, tongues of this forest extended upward almost to the tops of the ridges, often following the course of ravines. Here at 5,000 to 6,000 feet it gradually blended with the alpine fir and Englemann spruce forest characteristic of the higher regions. Some of the best stands of cedar were noted on the tops of the ridges which are sometimes relatively flat and plateau-like over limited areas. Where pure stands of cedar occurred, to the exclusion of all other forest trees, there was rarely any appreciable undergrowth. The forest was dense, dark and heavily hung with lichens and the forest floor was bare of vegetation except for numerous fungi, as well as masses of fallen branches and trees.

The following species of plants were noted most commonly in the fir, cedar and yew forest:

*Adiantum pedatum*
*Pteridium aquilinum*
*Abies grandis*
*Thuja plicata*
*Taxus brevifolia*
*Clintonia uniflora*
*Montia sibirica*
*Berberis repens*
*Boykinia major*
*Heuchera* sp.
*Ribes cognatum*
*Holodiscus discolor*
*Rubus parviflorus*
*Fragaria bractata*
*Crataegus brevispina*
*Acer glabrum*
*Rhamnus purshiana*
*Sphaeralcea rivularis*
*Cornus canadensis*
*Campanula rotundiflora*
*Micromeria chamissonis*
*Solanum Dulcamara*
*Synthyris* sp.
*Symphoricarpos albus*
*Lonicera ciliosa*
*Hieracum columbianum*
*Aster Fremontii*

With but a single exception none of the mammals encountered in the Selway region appeared to be restricted solely to this type of forest. One species of chipmunk (*Eutamias amoenas*) was rarely found much above this forest belt, the highest elevation at which it was observed being 4,500 feet. It was replaced in the higher spruce and fir forests by another species (*Eutamias ruficaudus*). Solid stands of pure cedar appeared to be singularly unproductive, due probably to the scarcity of undergrowth. Only shrews and flying squirrels seemed attracted to dense cedar forests.

*Fir and spruce forest.*—On the tops of the ridges and on the more protected upper slopes, somewhat lower zonally than the lodgepole and white pine association, a fir and spruce forest predominated. The principal conifers in this association were Englemann spruce (*Picea Englemannii*), alpine fir (*Abies amabilis*), grand fir (*Abies grandis*), western red cedar (*Thuja plicata*), occasionally Douglas fir (*Pseudotsuga taxifolia*) and, in more open situations, western larch (*Larix occidentalis*). The undergrowth in such a forest was generally very dense, conserving moisture on the floor of the forest and inducing the growth of many different types of fungi. The principal trees and shrubs composing this "substratum" were western yew, dwarf maple, thin-leaf alder, snowberry, thimble-berry, thin-leaf huckleberry, rustyleaf, service berry and spirea. The forest floor was likewise densely carpeted with numerous smaller plants. In more open situations, however, bracken and elk grass formed the main cover.

The following species of plants were those most conspicuous in general within this association:

| | |
|---|---|
| *Pteridium aquilinum* | *Aquilegia* sp. |
| *Larix occidentalis* | *Tiarella unifoliata* |
| *Picea Englemannii* | *Spirea corymbosa* |
| *Pseudotsuga taxifolia* | *Rubus pedatus* |
| *Abies grandis* | *Amelanchier Cusickii* |
| *Abies amabilis* | *Pachystima myrsinites* |
| *Thuja plicata* | *Acer glabrum* |
| *Taxus brevifolia* | *Chimaphila umbellata* |
| *Xerophyllum tenax* | *Menziesia ferruginea* |
| *Clintonia uniflora* | *Vaccinium macrophyllum* |
| *Salix* sp. | *Symphoricarpos albus* |
| *Alnus sinuata* | *Adenocaulon bicolor* |

In the more dense and typical portions of this forest the only coniferous trees, aside from western yew which actually formed a dense undergrowth, were Englemann spruce and alpine fir. The other species of conifers usually occurred where the forest was either of a more open type or along the margins.

Two species of mammals appeared in this region to be rather typically associated, although at least one of them was not restricted, to this fir-spruce association. These were *Eutamias ruficaudus* and *Clethrionomys gapperi*. The former species was also noted in lodgepole pine forests and in brushland at high elevations.

*Lodgepole pine forest.*—Lodgepole pine (*Pinus contorta* var. *murryana*) occurred scatteringly in most of the forest associations where suitable conditions prevailed. Relatively pure stands, however, were found locally at higher elevations. A few western white pines (*Pinus monticola*) were generally present in any extensive lodgepole pine forest. On the upper parts of higher mountains, such as the Crags, where most of the timber had been burned off in 1934, there was evidence that extensive areas of lodgepole pine previously occurred. Many young trees, some twenty feet in height, were observed among the brushy cover of willow, alder and tobacco brush. Natural reforestation appeared in evidence over widespread areas. This was in marked contrast to burned over spruce, fir and cedar areas where occasional trees had survived but where there was very little indication of reforestation.

The following species of plants were most typical of this forest:

*Pinus monticola*
*Pinus contorta* var. *murryana*
*Carex* sp.
*Xerophyllum tenax*
*Spirea corymbosa*
*Ceanothus velutinus*
*Phyllodoce empetriformis*
*Vaccinium Myrtillus* var. *microphyllum*

This type of forest varied from dense stands of relatively small trees, in which underbrush was practically lacking, to open, loose stands, especially where previous burning had taken place. No mammals were observed to be restricted to this association.

*Brushland.*—Much of the territory north of the Selway Fork and east of Meadow Creek was extensively burned over by the great fire of 1910, and again by the "Pete King" fire in 1934 which destroyed hundreds of square miles of virgin forest in the upper watershed of the Middle Fork of the Clearwater River. As previously noted the higher portions, which were originally forested with lodgepole and white pine, showed considerable evidence of reforestation appearing amid the dense brush which presently covers most of the area. Lower down, however, there was little indication of fir, spruce and cedar reappearing and brush solidly covered the slopes. In the region west of Meadow Creek there appeared to have, likewise, been intensive fires many years ago, probably about 1889 (*fide* R. L. Hand in letter). These latter burned areas are still primarily brushland at present, although locally there are fair stands of pole-size timber. In many places the tops of the ridges have become grassland and support tall stands of grass with occasional old firs and spruces and standing snags scattered about.

The most common shrubs forming this brushland habitat resulting from fire were thin-leafed alder (*Alnus sinuata*), willow (*Salix* sp.), mountain ash (*Sorbus sitchensis*), dwarf maple (*Acer glabrum*) and snow berry (*Symphoricarpos albus*). Bracken (*Pteridium aquilinum*) and elk grass (*Xerophyllum tenax*) were widely distributed throughout, especially in small clearings. Certain other herbs such as *Rudbeckia occidentalis*, *Polygonum Douglasii* and *Epilobium* sp. were numerous. Higher in the mountains, especially above 6,500 feet altitude in the Crags, *Ceanothus velutinus*, *Spirea corymbosa*, *Phyllodoce empetriformis* and *Vaccinium Myrtillus* var. *microphyllum* were of importance in the composition of the brushland.

These fires and the resulting brushland have greatly affected the distribution of certain mammals over this region and obviously have resulted in the relative isolation of populations of forest-dwelling mammals in the various small "islands" of unburned timber that survived these catastrophes and are scattered about locally on some of the ridges and deep canyons. Few of the smaller mammalian species seem to have successfully reinvaded these once devastated regions and it appears likely that certain species will not do so until a climax forest is once again established.

The white-footed mouse (*Peromyscus maniculatus*) was one of the few species that appeared to be abundant in the burned over areas. It is possible that this rodent, which exhibits a great range of adaptability, possesses a greater population over the entire area now than previous to these fires. This may be due in part to the nearly complete absence of competition from other forms of small mammals in the burned areas. White-footed mice were trapped in such localities in numbers. The chipmunk (*Eutamias ruficaudus*) was another of the small terrestrial mammals that showed some ability to invade or at least survive to a limited extent in areas that had been severely burned. Peripheral brushland, adjacent to forest cover, where numerous snags still stood or littered the ground, was extensively inhabited by members of this species. At high altitudes where rock slides offered protection and shelter the immediately adjoining brushland, especially where this contained some snags and fallen trees, was likewise inhabited. Such talus slopes had undoubtedly acted as focal points for the repopulation of surrounding devastated areas.

The distribution of pocket gophers (*Thomomys talpoides*) did not appear to have been affected seriously by fire. This species in fact seemed more abundant in brushland than in forested sections. Mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) may also have benefitted as a result of fire, due to the increase in browsing land.

Many other species of mammals, however, without question have suffered severely as a consequence of the depletion of forest cover. Shrews, red squirrels, flying squirrels, red-backed mice, meadow mice and certain other forest-requiring species will be restricted to the remaining timbered areas until such time as a sufficiently extensive forest growth once again develops in the areas now covered with brush.

## Species Accounts

### **Sorex vagrans monticola** Merriam. Wandering Shrew

Although most of the areas where trapping was carried on seemed to offer exceptionally favorable habitats for shrews these animals appeared scarce. Four wandering shrews, nos. 8312–8315, were secured between September 14 and 23, from three to four miles southwest of Selway Falls, at elevations varying from 5,500 to 5,800 feet. Two of these were trapped amid fallen bark and other litter in a dense cedar forest, while the other two were taken beneath dense undergrowth in mixed spruce, alpine fir and cedar forests.

Three specimens are in worn summer pelage; a fourth, taken on September 20 possesses new winter pelage on all but the head and shoulders. The weights of two males are 6.1 and 5.2 grams.

### **Sorex obscurus obscurus** Merriam. Dusky Shrew

A single adult male, no. 8316, of this species in fresh winter pelage was taken on September 24, 6 miles southwest of Selway Falls at an altitude of 5,800 feet. It was trapped in an area densely forested with spruce and alpine fir adjacent to an extensive lodgepole pine forest. The weight of this individual was 5.9 grams.

### **Myotis evotis chrysonotus** (J. A. Allen). Long-eared Bat

A single individual of this species, no. 8317, was taken on the evening of September 8, shortly before dusk. It was shot as it flew over a bridge on Meadow Creek, two miles south southeast of Selway Falls at 1,900 feet elevation.

### **Myotis volans interior** Miller. Long-legged Bat

Four individuals, nos. 8318-8321, of this species were secured, one on September 16 and three on September 23. All were shot just before dusk as they flew above a road leading through a moderately dense Englemann spruce and alpine fir forest, four miles southwest of Selway Falls at 5,800 feet elevation. *Myotis californicus* was associated with this species when foraging.

A remarkable range in color variation is to be noted among the specimens secured. One compares favorably in color with the race *interior* from the Great Basin region of western United States, whereas the other three are so dark in general appearance that they were at first thought to be representatives of the race *longicrus* which occurs not far to the north and west and which might indulge in local or seasonal population movements. It was later decided, however, that these three specimens were probably immature and in a subadult pelage. The resemblance of immature specimens of *interior* to adults of *longicrus* has been noted by Miller and Allen (1928, p. 141).

**Myotis californicus californicus** (Audubon and Bachman).
Little California Bat

Eight specimens, nos. 8322-8329, of the little California bat were secured in the Selway Falls region, between 1,900 and 5,800 feet elevation. All were taken as they foraged over roads or watercourses in forested areas in the evening.

**Ursus americanus cinnamomum** Audubon and Bachman.
Black Bear

Black bears appeared to be moderately abundant in this region, judging from the numerous signs and tracks observed, especially along the banks of watercourses and trails in canyon bottoms. On September 8 a hole dug by a small black bear the previous night was found in a small sandy beach along Meadow Creek close to camp. Only one bear was seen, however. This was in the late afternoon of September 18 near an unoccupied Forest Service Lookout Station at Falls Point, on a ridge about one mile southwest of Selway Falls. One skull, no. 8330, of a half-grown individual was found in good condition two miles south southeast of Selway Falls on September 24.

**Procyon lotor excelsus** Nelson and Goldman
Raccoon

Although raccoons have never been recorded this far north in Idaho their presence is here reported in the Clearwater Mountains on the basis of information supplied by Mr. R. L. Hand of the U. S. Forest Service, Missoula, Montana, who was stationed for seven years in the region of the Middle Fork of the Clearwater River and its tributaries. Mr. Hand in a letter to the writer, dated February 17, 1942, states as follows: "Actually, though they [raccoons] are by no means common, almost every trapper who covered the lower Selway and Lochsa rivers got a 'coon or two each season. I have examined hides from O'Hara Bar, Ratcliff Creek and the upper Middlefork and lower Lochsa and seen tracks frequently."

No signs of raccoons were noted by members of the Academy's expedition in the vicinity of Selway Falls, but this region for the most part is rather high zonally for this species. Ratcliff [Rackcliff] Creek, the nearest locality from which skins are reported as having been taken by trappers, is about ten miles west northwest of Selway Falls. While this is over three hundred miles north of the nearest locality in Idaho from which Davis (1939, p. 128) records this species, it is only about seventy-five miles east of the Snake River Valley in southeastern Washington from which Nelson and Goldman (1930, p. 458) record *Procyon lotor excelsus*.

### **Martes caurina caurina** (Merriam). Marten

Martens are reportedly of widespread occurrence throughout the higher portions of the Clearwater Mountains. Shortly before sunset on September 16 a marten was seen in the crown of a dense spruce, four miles southwest of Selway Falls. This individual disappeared in the dense foliage as rapidly as it had appeared (Loukashkin, MS). The skull of an immature marten, no. 8331, was found close to a deserted trapper's cabin, six miles southwest of Selway Falls, on September 22.

### **Mustela cicognanii cicognanii** Bonaparte. Short-tailed Weasel

Two short-tailed weasels, nos. 8332-8333, were secured in small steel traps. One of these, an adult male, was caught two miles south southeast of Selway Falls on September 11, in a rocky situation close to Meadow Creek. Grand fir, red cedar and western yew were the principal trees here. The second individual, a female, was taken along a trail in a dense spruce forest, four miles southwest of Selway Falls on September 15. Another female, no. 8334, was shot as it ran along a trail in a spruce forest close to the second camp in the late afternoon of September 16. On September 25 the desiccated remains of a fourth individual, thought to be a female judging from its small size, was found on this same trail. The skull of this animal was saved, no. 8339.

The skins of the specimens collected show no indication of winter pelage appearing. The weights of one male and two females are 102.9, 59.0 and 65.9 grams, respectively.

### **Mustela frenata nevadensis** Hall. Long-tailed Weasel

On September 22 a male long-tailed weasel, no. 8335, was caught in a small steel trap placed at the base of an uprooted stump in a dense fir and spruce forest close to our second camp. At noon on September 25, while the writer was approaching a chipmunk on a pile of logs not far from the above locality, a weasel of this species was seen a short distance away. It was moving about actively over and under fallen logs, branches and other forest debris and was apparently so engrossed that, although it approached within less than ten feet of the observer, it failed to notice him. When about twenty-five yards away a few moments later it was shot. This specimen, no. 8336, proved to be a female. Both of the above mentioned specimens are in summer pelage. The weights of the male and female are 184.4 and 149.9 grams respectively.

The skull of a long-tailed weasel, no. 8340, was found close to a trapper's cabin, six miles southwest of Selway Falls, on September 28.

**Mustela vison energumenos** (Bangs). Mink

A female mink was caught on the morning of September 12 in a steel trap placed near Meadow Creek, two miles southeast of Selway Falls. When the trap was approached another mink was seen close by, but it rapidly disappeared in the adjacent forest undercover. The trapped animal was exceedingly vicious and succeeded in lacerating the collector's hand before it was dispatched (Loukashkin, MS).

The single specimen collected, no. 8337, weighed 565.6 grams. It is exceptionally dark for this race, as was noted by Davis (1939, p. 138) for all of the specimens from Idaho at his disposal.

**Spilogale gracilis saxatilis** Merriam. Spotted Skunk

On September 14, a spotted skunk was caught about four miles southwest of Selway Falls at an elevation of 5,800 feet. It was taken in a steel trap placed in a crotch at the base of a divided Englemann spruce. Although the situation was a most unusual one for a member of this species, being in a dense Canadian Life Zone forest, it was only about 100 yards from a grass and brush-covered ridge that contained but a scattering of timber.

None of the residents of this region contacted by members of the Academy party knew of the presence of spotted skunks in this part of the state, although all were familiar with the striped skunk. So far as known this locality is about 160 miles north of the northernmost record for *Spilogale gracilis* in Idaho. The heretofore known range of the species, however, approaches the Clearwater Mountains more closely in eastern Oregon and southeastern Washington (*cf.* Bailey, 1936, p. 312).

According to Whitlow and Hall (1933, p. 248) a single skin examined by them from the vicinity of American Falls in southern Idaho exhibits an extreme restriction of the white markings even for the race *saxatilis*. The specimen collected in the Clearwater Mountains, a subadult male, no. 8338, shows quite the reverse. The white markings are more extensive than in any specimens of *saxatilis* examined, resembling very much the pattern possessed by the race *phenax* of California. Cranially, however, this individual resembles comparable specimens of the former race.

**Mephitis mephitis** (Schreber). Striped Skunk

The presence of striped skunks in the vicinity of Selway Falls was apparently known to a number of residents of the region but members of the Academy party failed to secure any specimens. Until a series is available, however, it will remain conjectural as to whether representatives of the species from this region may be referred to *Mephitis mephitis hudsonica* or to the more southern form *M. m. major.*

### **Canis latrans lestes** Merriam. Coyote

No individuals of this species were collected or seen. Tracks, however, were observed regularly, especially on the tops of ridges. Although occasionally noted in dense forests of spruce, they were most frequently seen in more open situations, especially along trails through brush and grassland. Early on the morning of September 28 several coyotes were heard calling some distance away in a lodgepole pine forest six miles southwest of Selway Falls. That evening a single individual was again heard calling in the same vicinity.

### **Felis concolor hippolestes** Merriam. Mountain Lion

No mountain lions were seen in this region but their abundance in the Clearwater Mountains was attested to by local U. S. Forest Service officials and employees of the U. S. Fish and Wildlife Service. Large herbivores such as elk, mule deer and white-tailed deer, upon which this species normally preys, were numerous.

### **Lynx rufus pallescens** Merriam. Bobcat

Bobcats were reportedly abundant over most of this region. No specimens were secured but their tracks were noted not infrequently along trails both in forested and brushy country.

### **Marmota caligata nivaria** Howell. Hoary Marmot

### **Marmota flaviventer avara** (Bangs). Yellow-bellied Marmot

Marmots were reported by local residents to be widely distributed over the drainage of the Middle Fork of the Clearwater River, occurring generally where rocky situations were present. As these animals are all in hibernation by the middle of August none was seen or collected. Numerous droppings, however, were observed on the upper granitic slopes of Fog Mountain and in talus slopes bordering Canteen Meadows in the Crags Mountains. In the latter region, marmots were undoubtedly associated with bushy-tailed woodrats and conies.

From information derived from various sources it would appear that both the yellow-bellied and hoary marmot are present in the Clearwater Mountains, the former occurring generally at lower altitudes, the latter at higher altitudes. R. L. Hand in correspondence (February 17, 1942) states: "In the Lochsa district both the hoary marmot (*Marmota caligata*) and a race of *Marmota flaviventer* occur quite commonly. While the latter is more of a low altitude species I am quite certain that the ranges of the two meet and overlap in the Lochsa Canyon. Actually I have seen the former only above the Lochsa Ranger Station, and the latter some 15 or 20 miles below and on down the Middle Fork. The hoary marmot seems most common at the higher altitudes and I distinctly remember running on to an individual or two near Stanley Butte which is just north of the Crags. I should certainly expect to find the smaller brown species [*flaviventer*] along the Selway River."

### **Citellus columbianus columbianus** (Ord).
Columbian Ground Squirrel

Columbian ground squirrels were all in hibernation in September, but numerous burrows, presumably occupied by members of this species, were noted from the deepest canyon bottoms to the tops of the higher ridges. Their widespread occurrence over this region was well known to all persons contacted who were familiar with the Selway River country.

### **Citellus lateralis tescorum** (Hollister).
Mantled Ground Squirrel

Members of this species had also entered hibernation by early September when the Academy's expedition arrived in the Clearwater Mountains. Their presence on Coolwater Ridge, separating the lower Selway and Lochsa rivers, and in the Crags Mountains, however, was reported by a number of reliable observers familiar with this region. Here, as is generally true of the species throughout its range, they were said to inhabit mainly rocky situations.

The subspecific name *tescorum* is herein used on the basis of A. H. Howell's revision of the ground squirrels (1938, p. 199), no specimens having been examined by the writer.

### **Eutamias amoenas luteiventris** (Allen).
Buff-bellied Chipmunk

This species was found to be very abundant throughout forested country and in marginal brushlands at elevations below 4,500 feet. It was not found, however, in the higher Englemann spruce forests where *Eutamias ruficaudus* occurred. As is true generally of this species throughout its range *Eutamias amoenas* was found to be primarily terrestrial, foraging over the ground and along fallen logs. Individuals were occasionally seen on the lower branches of trees, especially yews, the berries of which were eaten. When approached they would invariably attempt to get to the ground rather than escape by ascending higher into the trees. The cheek pouches of a female taken on September 8 contained a number of seeds of grand fir. The wings of the seeds had been removed.

The following trapping data gives some evidence of the abundance of members of this species in the Selway Falls region in September 1941. At mid-morning on September 6, 40 mouse traps were placed out in a semi-circular area within a radius of 100 yards of the center of our first camp on the east bank of Meadow Creek. By 2 p.m. 22 chipmunks had been captured. Between 2 p.m. and sunset four more were taken and at 6 a.m. the next morning three more were in the traps. The traps, of course, were visited often and reset when found sprung. Even this did not seem to represent the total chipmunk population foraging over this very limited area as more individuals were seen here during the day of September 7 when the traps were removed and on succeeding days. Of this total of 29 individuals secured around camp in less than 24 hours, six contained one or more large bot fly (*Cuterebra*) larvae beneath the skin. The greatest number noted on any one chipmunk was three. These larvae were located on the neck, chest, back, flank and beneath the ear. Five additional individuals possessed capsules beneath the skin from which larvae had already emerged. The incidence of infection by these parasitic flies seemed especially high, therefore, as shown by 11 out of 29 specimens secured over a very limited area either being currently infected, or giving indication of having recently been infected.

The series of *Eutamias amoenas* obtained from the Selway region shows a very intense pigmentation on the ventral part of the body. It is more marked in these specimens than any comparable examples of the race *luteiventris* examined from Montana, southern British Columbia or extreme northern Idaho.

A total of 35 specimens, nos. 8380-8414, were secured two miles south southeast of Selway Falls. These represent 30 skins plus skulls, four skulls only and one complete skeleton. Of this number 15 are males and 20 are females. The average and extreme measurements in millimeters of 14 males are: Total length, 204 (193-214); tail length, 88.4 (80-98); hind foot, 31.9 (31-34); ear from notch, 17.1 (16-19). The average and extreme measurements in millimeters of 19 females are: Total length, 209.1 (191-222); tail length, 91.2 (77-98); hind foot, 31.8 (31-33.5); ear from notch, 16.9 (15-19). The average and extreme weights in grams of 14 males and 19 females are 50.6 (45.3-55.4) and 53.6 (44.4-62.7), respectively.

### **Eutamias ruficaudus simulans** Howell.
Rufous-tailed Chipmunk

In general this species of chipmunk was very abundant higher in the mountains, being a common resident of the Englemann spruce and alpine fir association. A single specimen was secured on September 6 in a lowland fir and cedar forest along Meadow Creek at

1,900 feet altitude. This was the only individual noted below 4,500 feet. On September 20, members of this species were seen at an altitude of 7,000 feet in the Crags Mountains.

These chipmunks were found to be much more arboreal in habits than *Eutamias amoenas*, which occurred at lower elevations. Much of their foraging was carried on in trees and in a large number of instances they were found to have nest holes in trees or standing snags. Although forest-dwelling for the most part, many marginal tracts of brushland in which snags were still standing were inhabited by these chipmunks. In one place a broken, dead fir, approximately 18 feet in height, was seen to house six individuals. These six chipmunks were observed daily in this tree for a period of a week, and each seemed to possess a separate hole in the main trunk in which it would take refuge.

On September 14, two chipmunks were observed picking up feathers about camp, four miles southwest of Selway Falls. These were placed in their cheek pouches and later carried to their burrows where undoubtedly they served for nest material. Many chipmunks were caught in small steel traps baited with meat for small carnivores such as weasels. Two chipmunks secured in brushland on September 23 had their cheek pouches filled with the seeds of *Polygonum Douglasii*. During the last week in September when the weather was quite cold there was a noticeable decrease in the number of chipmunks seen.

Thirty-nine specimens, nos. 8341–8379, representing 16 males and 23 females, of *Eutamias ruficaudus* were secured. The average and extreme measurements in millimeters of 16 males are: Total length, 219 (207–246); tail length, 95.5 (82–111); hind foot, 32.6 (31–35); ear from notch, 17.5 (16–21). The average and extreme measurements in millimeters of 19 females are: Total length, 219.4 (206–236); tail length, 95.6 (88–106); hind foot, 32.4 (31–34); ear from notch (18 averaged), 17.3 (16–19). The average and extreme weights in grams of 16 males and 19 females are 55.5 (46.5–66.3) and 57.5 (46.5–70.2), respectively.

### **Tamiasciurus hudsonicus richardsoni** (Bachman).
### Red Squirrel

Red squirrels were abundant throughout the forested portions of this region, but most numerous where either grand or alpine fir occurred. During September red squirrels were seen to ascend regularly to the tops of firs in the early morning to cut off cones. Sometimes they would dismantle the cones in the tree tops and secure the seeds there, the presence of a squirrel being more often detected by the steady dropping of chips and seeds rather than by any sound it made. Generally, however, the cones were cut off and let drop to the ground. After several cones had been dropped the squirrel would descend and secure them. These cones were often then taken apart on logs, the cone scales being left in a pile while the seeds that were secured were carried away.

A total of 29 specimens, nos. 8415–8443, was secured. Of this number 15 are males and 14 are females.

### **Glaucomys sabrinus bangsi** (Rhoads). Flying Squirrel

Flying squirrels appeared to be fairly common in the more heavily forested portions of the Selway River region, being more often detected at night by sound rather than by sight. Flying squirrels were seen or heard almost nightly in the vicinity of our first camp on Meadow Creek. Here, in a grand fir and red cedar forest, one or more individuals were regularly observed by lamp light gliding from tree to tree shortly after dark. High pitched notes emitted by these squirrels were commonly heard in the surrounding forest at night. One specimen was trapped close to this camp on September 11, and two additional specimens were secured four miles southwest of Selway Falls at 5,800 feet altitude. One of these was taken in a cedar forest on September 18 and the other in a dense spruce forest on September 29. All three individuals were caught in small steel traps baited with meat and placed on the ground.

These specimens were found on comparison to agree with a large series from Golden, Idaho County, which were reported on by Mayer (1941) and placed in the race *bangsi*. The two individuals taken on September 11 and 18, respectively, are in worn summer pelage with new winter pelage appearing beneath the surface of the old hairs on the shoulders, sides, flanks and posterior part of the back. The specimen taken on September 29 has new pelage on the entire dorsal surface, with the exception of the head. Worn pelage remains on the ventral parts of the body but new pelage is readily apparent beneath the surface. The weights of three males, nos. 8444–8446, collected are 94.1, 109.5 and 159.2 grams.

### **Thomomys talpoides saturatus** Bailey. Pocket Gopher

Pocket gophers were distributed locally over this region. Very few signs of this species were noted in the canyon bottoms which were quite rocky and lacking in grassy clearings. Over a period of eight days only two separate workings were noted along Meadow Creek canyon from its junction with the Selway River to a point three miles upstream. One specimen was secured in the vicinity of our first camp, two miles south southeast of Selway Falls. The scarcity of pocket gophers was also apparent on the steep, rocky slopes of the mountains. On the tops of the mountains, however, where considerable fine top-soil was present, pocket gophers were numerous. Their workings were found to be almost equally numerous in heavily forested country, where, of course, there was considerable low-growing vegetation, as on more or less open, grassy ridge tops. Burned over areas, grown up with brush and containing many small clearings, appeared to present optimum conditions for members of this species in this region.

Twenty-eight specimens, nos. 8447–8474, were secured and of this number 13 were males and 15 were females. This series on comparison with *Thomomys t. fuscus* from central Idaho appears darker in coloration, agreeing in this respect with specimens from northern Idaho which were considered by Davis (1939, p. 256) to be best placed with the race *saturatus*.

### **Castor canadensis** Kuhl. Beaver

Many signs of beavers were noted along the lower part of Meadow Creek, especially where the water was relatively deep and flowing quietly. So far as could be determined these animals inhabited holes in the banks of the creek, the entrances being below the surface of the water. No dams were observed, nor were they necessary due to the permanence of the water supply.

Many beaver cuttings were seen along the shores of the creek. Among the species of trees and shrubs cut were grand fir, western red cedar, western yew, service berry, snowberry and willow. Where the latter occurred in beaver territory it was usually trimmed to the ground, apparently being a preferred food. Some of the firs and cedars cut measured up to 10 inches in diameter. Occasionally partly cut larger trees were noted, the largest one seen being two feet in diameter, and at a distance of 25 feet from the edge of the water. On one occasion a living cedar, which had fallen, probably as a result of a storm, with part of its crown submersed in the creek, was found to have all the tips of the branches cut off by beavers. Frequently the smaller vegetation, such as sedge and horsetail growing along shore, was noticeably trampled down by these animals.

Shortly before dusk on the evening of September 7, about one-half mile up Meadow Creek from our first camp, a beaver was seen. It was heard to hit the water with its tail as it started to swim across the stream. The noise was a dull thump which, however, had considerable carrying power. A second beaver was believed to be present but visibility was too poor to be certain. The writer and Cecil Tose returned to a point about 150 yards below this same locality on the following night at 8:15 p.m., equipped with a strong spotlight. An approach was no sooner made than a beaver was heard to hit the water with its tail. Upon turning on the light it was seen swimming toward the center of the stream where it turned abruptly and swam down stream. After continuing down stream it made a sharp right angle turn and swam toward the observers. Each time, before turning, it dived momentarily, slapping the water with its tail as it did so. This behavior, consisting of sharp turns while swimming accompanied each time by a shallow dive and the slapping of the water with its tail, continued for some time. Finally, it became frightened, dived and was not seen again that evening.

### **Peromyscus maniculatus artemisiae** (Rhoads). White-footed Mouse

White-footed mice were widely and abundantly distributed over all portions of the Selway River drainage in which trapping was carried on. The following data at our camp on Meadow Creek gives evidence of the abundance of this species. Forty traps placed out on the evening of September 6 in a semi-circular area possessing a radius no greater than 100 yards contained 15 mice by 10 p.m., and at 6 a.m. the following morning three additional individuals were found to have been caught during the night. This, of course, was in a camp that appeared to be regularly used, at least during the summer, and represented a somewhat higher population than was present over the entire area in general. Where information was definitely recorded in the field notes of members of the party as to the exact number of mouse traps placed out at night and the succeeding catches the next morning it was found that 670 known trap nights produced, among other small mammals, 91 white-footed mice. This represents the results of trapping in varied forest habitats, brushland and riparian growth. A number of those mice taken at lower altitudes were found to be infected with bot fly larvae.

One individual, captured on September 7, was found to have 11 seeds of cascara sagrada (*Rhamnus purshiana*) in its cheeks.

Although a large number of half-grown young were taken, only one female was found to be pregnant. This individual was captured on September 7, two miles south southeast of Selway Falls, and contained four embryos averaging 16 millimeters in length. Another taken on this same day showed signs of nursing young. On the morning of September 8 at 10:30 o'clock a small, shrill, bird-like call note was heard repeatedly in a thicket of brush about camp. On investigating it proved to come from a young white-footed mouse that had wandered from its nest and was not yet old enough to feed itself. The mother had probably been trapped on the night of September 6-7.

The series of 29 specimens, nos. 8476–8504, secured in this general area appears to be typical *artemisiae*, exhibiting none of the subspecific characters of the race *serratus* recently described by Davis (1939, p. 290). The average and extreme weights in grams of 12 males and 10 females are, respectively, as follows: 21.1 (19.4–23.5) and 25.4 (19.6–34.4).

### **Neotoma cinerea occidentalis** Baird. Bushy-tailed Wood Rat

Bushy-tailed wood rats occurred locally throughout this area wherever the terrain was rocky, and were also found about deserted human habitations. Talus slopes, such as were inhabited by conies in the Crags Mountains, were found to contain numerous signs of wood rats.

Four specimens were secured, nos. 8505–8508. Three of these were taken about camp, two miles south southeast of Selway Falls, 1,900 feet altitude, and the fourth was trapped at a deserted cabin six miles southwest of Selway Falls at 5,800 feet altitude. These few specimens appear to be intermediate in character between *Neotoma cinerea occidentalis* and *N. c. alticola* approaching nearer, however, to the former (*cf.* Hooper, 1940, p. 418).

### **Clethrionomys gapperi idahoensis** (Merriam). Red-backed Mouse

Red-backed mice were taken only in spruce and fir forested areas at higher elevations, intensive trapping in canyon bottoms in situations seemingly suitable for members of this species producing no results. At higher altitudes red-backed mice were moderately common in coniferous forests where there was an abundant undergrowth of dwarf maple, alder, yew, and snowberry as well as numerous fallen logs. One individual was trapped in a crotch in a spruce tree at a height of three feet above the ground.

The majority of red-backed mice captured were immature, many of them being less than half-grown. One adult female, taken on September 13, carried three embryos measuring 22 millimeters in length. A total of 40 specimens, nos. 8509–8548, was secured, 24 being males and 16 females.

This series agrees with those specimens from southern Idaho, in the collection of the Museum of Vertebrate Zoology, which were assigned to the race *idahoensis* by Davis (1939, p. 311). It may here be remarked, however, that the differences between *Clethrionomys g. idahoensis* and *C. g. saturatus* are very slight.

### **Microtus longicaudus mordax** (Merriam). Long-tailed Meadow Mouse

Meadow mice were relatively scarce in those portions of the Selway drainage in which trapping was carried on. This was probably due to the scarcity of mountain meadows and grassy streamside banks, except locally at high elevations where glaciation had occurred. The greatest number secured at any one time was on September 9 when four individuals were taken from 30 traps placed over a very limited area along Meadow Creek. Three of these were caught in traps placed among horse-tail, sedge and grass, growing within 15 feet of the creek. The fourth was secured next to a fallen log in the forest, a few yards from the stream, where wild strawberries formed the principal ground cover. On the tops of ridges meadow mice were occasionally taken in dense spruce and fir forests in association with red-backed mice. They were nowhere near as numerous, however, as was the latter species. A total of 10 individuals, nos. 8549–8558, in all was secured.

**Microtus richardsoni macropus** (Merriam).
Richardson Meadow Mouse

A single immature individual, no. 8559, of this species was secured on September 17, 4 miles southwest of Selway Falls at 5,800 feet elevation. It was taken in a trap set on a mossy ledge in the center of a small rivulet having its origin at a spring several hundred yards above. When found the extremities of this animal were partly submerged and being eaten by leeches.

**Erethizon epixanthum epixanthum** Brandt.
Yellow-haired Porcupine

Although no porcupines were seen, a skull and part of the skeleton, no. 8475, of one was found by Dr. Hanna one mile above Selway Falls on September 10. Undoubtedly these animals are common throughout the forested portions of this region.

**Ochotona princeps princeps** (Richardson). Pika

On September 20 many pikas were heard in the talus slopes surrounding Canteen Meadows in the Crags Mountains. Although it was quite cold a few individuals were seen as well as heard at noon when there was intermittent sunshine. All disappeared by 2:30 p.m., at which time it began to snow lightly. Snow continued falling during the remainder of the afternoon and, although pikas were heard beneath the rock slides, only one individual was seen. Late in the afternoon a pika was seen on top of a rock, in the snow, by Tose who promptly collected it.

Due to the general plateau-like surfaces of the mountain tops and the sheer, eroded sides of the canyons there were few talus slopes for these animals except in the highest areas.

The one specimen secured, no. 8560, agrees in characters with the race *princeps*, as represented by a series in the University of California Museum of Vertebrate Zoology from the vicinity of the Glidden Lakes, Shoshone County, Idaho.

**Lepus bairdii bairdii** Hayden. Snowshoe Rabbit

Snowshoe rabbits were peculiarly localized in their distribution over the Selway River region. They were in fact noted only in two limited localities about five miles apart. The intervening territory, as well as many portions of the surrounding country, appeared equally suitable for these animals but, while careful search was made for rabbits or signs of such, no evidence indicating their presence was found.

Shortly after dark on the evening of September 10, and again on the evening of September 15, a snowshoe rabbit was seen along the edge of the road about one mile southwest of Selway Falls at an altitude of approximately 4,500 feet. The forest cover here was rather open with, however, a dense undergrowth of brushy species present. On September 27, snowshoe rabbits were discovered inhabiting dense undergrowth in a spruce-fir forest six miles southwest of Selway Falls at 5,800 feet elevation. This undergrowth consisted principally of western yew, thin-leaf alder, dwarf maple, and snowberry. The following evening at dusk four rabbits were observed along the edge of a road in this vicinity over a distance of one-half a mile. One of these was secured. This specimen, no. 8561, is a male with new white winter pelage appearing on the ventral parts of the body.

### **Cervus canadensis nelsoni** Bailey. American Elk

Elk were very abundant in those portions of the Selway River drainage visited. Tracks and signs were of equally common occurrence from the canyon bottoms to the tops of the higher ridges. According to Parsell (1938, p. 23) elk were scarce here in the early days and it is only within the past 20 years that their numbers have greatly increased to the present estimated population of 11,000 in the Selway National Forest. This great increase has been attributed in large part to the extensive burning that has occurred over much of this area, resulting in large tracts of brushland which provide adequate winter food for elk.

Although fresh elk signs were noted daily and individuals could regularly be heard morning and evening higher on the ridges, the animals themselves, despite their abundance and size, were seen but rarely. Bulls were heard bugling principally in the early morning, late afternoon and evening, their cries resounding from every canyon. Judging from observations made, much of the day was spent well down in the canyons. In the late afternoon the bulls, at least judging from their calls, gradually ascended to the ridge tops. In many places on the tops of the ridges, especially where brush and grassland intermingled, there were areas 10 to 15 feet in diameter where the ground and vegetation had been torn up apparently as a result of fighting.

On the evening of September 27, on Burned Ridge, west of Meadow Creek, the writer heard several elk bugling in the canyons on either side of the summit shortly after sunset. One individual could be heard rubbing its antlers on a tree several hundred yards down a canyon to the south. To the north several hundred yards, in a canyon on the opposite side of the ridge, two other individuals were heard crashing about in the brush as they moved toward the summit. The one in advance was not bugling but the other, following some distance behind, was calling although not with the usual series of ascending notes. Its cry somewhat resembled that of a steer. Finally, after a few minutes, the first animal, a large bull elk, came into sight, trotted up the ridge at a moderately rapid gait through brush and grassland and disappeared over the crest and down the south slope. About 10 minutes later the second animal appeared, following the same trail. The light was so poor, however, at this time that it was impossible to discern the antlers.

Numerous well worn elk trails were noted in equal abundance both in densely forested areas and in more or less open brushland.

### **Odocoileus hemionus hemionus** (Rafinesque). Mule Deer

Mule deer were reported to occur during the fall of the year in the higher parts of the mountains although it is highly probable that later in the year they would descend to lower elevations where the snow would not be so deep. Signs of mule deer were seen sparingly on the higher ridges. Elk signs were many times more numerous. It would appear, according to Case (1938, pp. 25-27), that the large number of elk present in this region is responsible for the present reduction in deer, due to scarcity of winter food.

No deer were seen although a single four-point antler and a portion of the skull of one, no. 8562, were found near Canteen Meadows, nine miles northeast of Selway Falls, on September 20. Incidentally it might be mentioned that more signs of deer were seen high in the Crags Mountains than elsewhere in this region. Signs of elk were very rare here. The abundance of granite rock and the scarcity of dense brush or forest cover likely was responsible for this difference in the relative abundance of these two species.

### **Odocoileus virginianus ochrourus** Bailey. White-tailed Deer

White-tailed deer were reported by local representatives of the U. S. Forest Service and U. S. Fish and Wildlife Service to occur principally in the canyon bottoms. Signs of deer, presumably members of this species, were noted not uncommonly in Meadow Creek and the Selway River canyons. On September 15, at sunset, a doe and yearling white-tailed deer were seen running through the forest, adjacent to the river, several miles below Selway Falls. Their tails were held high in the air as they ran.

### **Alces americanus shirasi** Nelson. Moose

According to Adams (1926), in his summary of big game animals on the National Forests, it was estimated that there were 485 moose present in the Selway National Forest in Idaho in 1925.

No moose were observed during the month of September but residents of this region have seen these animals in the higher mountainous area separating the Selway and Lochsa rivers, especially where lakes were present.

### **Ovis canadensis canadensis** Shaw. Mountain Sheep

A few mountain sheep are reported to occur in the Crags Mountains. On September 20, on Fog Mountain in the Crags Mountains region the following observations were made by Tose (MS): "Looking down into the cirque north of the lookout and on the sheltered side of the mountain I saw what appeared to be a sheep. It had seen us and stopped to look for a moment and then continued over a slight rise and out of sight. I first noticed it because of the white rump patch and then felt fairly certain it was a sheep by its heavy appearing body lines and by its loping or bounding gait. It did not have the heavy horns of a ram so must have been either a young ram or a ewe. The distance must have been about 450 yards from us."

### **Oreamnos americanus missoulae** Allen. Mountain Goat

Mountain goats were reported to be moderately abundant in the higher, rocky, mountainous area between the Selway and Lochsa rivers. R. L. Hand of the United States Forest Service at Missoula, Montana, writes [in letter of January 21, 1942] as follows: ". . . goats were fairly plentiful and at the time I left (about 1930) had increased in numbers and extended their range northward, at least to the Lolo trail on the Lochsa-North Fork Divide. I saw them frequently in bands of 15 to 20 individuals at different points between the Crags and the Lochsa River."

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## Plate 45

Fig. 1.—Looking eastward along the Selway River Canyon toward the Bitterroot Mountains from Falls Point, Idaho County, Idaho. Photograph taken September 19, 1941.

Fig. 2.—Meadow Creek about two miles above its junction with the Selway River, Idaho County, Idaho. Photograph taken September 10, 1941.

## Plate 46

Fig. 3.—A spruce and fir forest at an elevation of nearly 6,000 feet, four miles southwest of Selway Falls, Idaho County, Idaho. Photograph taken September 17, 1941.

Fig. 4.—Dense undergrowth typical of the spruce and fir forest association, three miles southwest of Selway Falls, Idaho County, Idaho. Photograph taken September 19, 1941.

## Plate 47

Fig. 5.—Tall grass and brushland in an area that was burned over years ago, approximately four miles southwest of Selway Falls, Idaho County, Idaho. Photograph taken September 17, 1941.

Fig. 6.—Looking north toward the Crags Mountains from Fog Mountain, Idaho County, Idaho. Photograph taken September 20, 1941.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

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**No. 36**

# MOLLUSKS OF THE CLEARWATER MOUNTAINS, IDAHO

BY

ALLYN G. SMITH
*Research Associate in Paleontology*

Previous to the California Academy of Sciences' expedition into the Clearwater Mountains of Idaho in the fall of 1941, this area had been relatively unknown to the conchologist. It thus affords considerable satisfaction to report on the molluscan fauna, which was collected in this region by Dr. G. Dallas Hanna, Dr. Robert T. Orr, Mr. Cecil Tose and Mr. Anatole Loukashkin.

The first extensive collection of land and fresh-water mollusks in Idaho was made by Henry Hemphill in the 1880's. The results of his work showed the extent of the fauna and brought to light a number of new species, several of them limited in range and strikingly different in their characters from species found elsewhere. The Academy, fortunately, is in possession of much of the original Hemphill material, including several lots of land slugs, which are still well-preserved in alcohol.

The route that Hemphill followed is not positively known. After collecting extensively in the vicinity of Great Salt Lake, Utah, he crossed the line into Idaho near Franklin, which was one of his collecting stations. His next group of collecting localities appears to be in the Salmon River Mountains along the banks of the Little Salmon and Salmon rivers on the road now designated as U. S. Highway 95 between New Meadows and White Bird, in Adams and Idaho counties. He did some collecting in the neighborhood of Stites, in northern Idaho County, and at Orofino, in Clearwater County, these localities being nearest to the Clearwater Mountains in northeastern Idaho County that were visited by the Academy's expedition. Hemphill also made extensive collections in the territory around Coeur d'Alene Lake, particularly at "Old Mission," Rathdrum, and Post Falls in Kootenai County, and at Kingston in Shoshone County.

In the early 1900's, the Rev. E. H. Ashmun moved from Arizona, where he had done much careful collecting, to Weiser, Idaho, where he held a pastorate for three or four years until poor health forced another move to the San Francisco Bay region. His collection, now being held intact by the author for Mrs. Ashmun, contains much land snail material from the drainage basin of the Weiser River from Weiser north to Meadows and the Payette Lakes, in Adams County.

In 1930, Dr. H. Burrington Baker collected along Hemphill's route at least as far as Orofino, covering the Salmon River Mountains within walking distance of the highway. He discovered several striking new species and re-collected several others taken originally by Hemphill.

In 1931, and again in 1941, the author made collecting trips along the same general route between Weiser and Lewiston. While the shells collected contained no new species, the re-discovery of three of Hemphill's species, formerly designated from the "Salmon River Mountains" or from the "banks of the Salmon," makes it now possible to report them from exact localities. The three species include *Oreohelix jugalis* (Hemphill), *O. intersum* (Hemphill), and *Triodopsis harfordiana* (Cooper). The first of these was found in piles of water-worn boulders near the west bank of the Salmon River, one mile north of Riggins; the second was collected sparingly in lava rock-slides facing east, to the west of the highway but several hundred yards away from the bank of the Little Salmon, about 3 miles south of Riggins; the third was found in rock-slides of blue limestone on the right side of John Day Creek, about 2 miles from its mouth. *T. harfordiana* was not uncommon at this location but, unfortunately, was not recognized in the field and only a few specimens collected.

Compared with the relative scarcity of native land snails in California, the Idaho region, generally, is a veritable collector's paradise, except perhaps in winter when snow conditions make collecting difficult or impossible, especially in the higher mountains. In favorable forested areas *Allogona ptychophora* and one or more races of *Triodopsis mullani* are common everywhere, more often than not being found in considerable numbers crawling about on the moist vegetation. At lower elevations, small species, such as *Vallonia cyclophorella*, *Helicodiscus salmonensis*, *Polygyrella polygyrella*, and *Columella edentula*, are easy to collect in quantity. In the Clearwater Mountains the Academy's collectors found this generally true except for a relative scarcity of the smaller species and the common occurrence of *Anguispira nimapuna* and the shelled-slug *Hemphillia camelus*. This can be attributed possibly to the absence of any limestone outcrops near the Academy's collecting stations and would also be a reason for the comparative rarity of *Oreohelix* there. As a rule, the presence of limestone formations in the Idaho region is an almost certain indication of the existence of a rich molluscan fauna, both in numbers of species and individuals.

In 1910 a very disastrous fire swept through a large area in central eastern Idaho, including part of the Crags Mountains. An excellent account of this fire may be found in Vol. 48, No. 7, of *American Forests*, for July, 1942. Brush and other vegetation has regrown on the lower parts of the burned over area but a new forest growth has scarcely started. The collecting party made a trip from Selway Falls to the Crags Mountains and careful search was made for small land shells and insects at an elevation of 6,000 to 7,000 feet where, up to the time of the fire, there had been a magnificent stand of timber. No mollusks and very few insects were found. Vegetation was limited to grasses and sedges, some annual flowering plants and scattered bushes of various kinds. In ordinary forest fires many land snails must escape destruction due to their habits and habitat but when one of these extremely hot conflagrations passes over a region it seems to wreak total extermination.

Fortunately the two camps made south of Selway Falls were in heavily forested areas which had never been burned so far as could be determined, and lumber interests had not done any logging. There most of the collection was made, and it may be assumed that the mollusks found represent the natural fauna undisturbed by man.

For an account of the geography, geology, fauna and flora of the territory visited by the expedition, the reader is referred to the preceding paper, "Mammals of the Clearwater Mountains, Idaho," by Dr. Robert T. Orr, of the Academy's Department of Ornithology and Mammalogy.

## List of the Species

The following list is based on the shells collected at four stations, ranging in elevation from around 1,900 feet to about 5,800 feet. A total of twenty-one species and subspecies were taken, including one new to science that is described and figured on subsequent pages. For several species the habitat range is extended beyond previously known limits.

## GASTROPODA: CAMAENIDAE

### **Oreohelix strigosa goniogyra** Pilsbry

*Oreohelix strigosa goniogyra* Pilsbry, 1939, p. 428, figs. 279:12-16.

Described originally from shells collected by H. B. Baker on lower Race Creek, in Idaho County, at 1700–1800 feet elevation, it was with some surprise that this carinated subspecies of *strigosa* was collected by the Academy's expedition at two new localities.

Specimens were scarce and hard to find in spite of a diligent search. Identification is confirmed by comparison with a set of 20 shells collected by the author at or near the type locality in June, 1941 (AGS 7848).

The expedition's shells agree well with Pilsbry's excellent figures, except that there is less of a tendency toward multiple banding. Of eight adult or nearly adult specimens collected, six were strongly double banded, the other two being plainly colored with brown flecks and subobsolete bands.

C. A. S. 31,499 Meadow Cr., 1½ mi. south of Selway Falls, Idaho Co., Idaho; elev. 1900 feet. Four adults, seven immature specimens.

C. A. S. 31,500 4½ mi. southwest of Selway Falls; elev. 5800 feet. Three adults, three immature specimens.

Shells from Locality 31,500 are somewhat less strongly carinate with more deeply impressed sutures. Measurements of adult specimens are as follows:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| C. A. S. 31,499 | Diameter, | 23.4 | mm. | Height, | 16.7 | mm. | |
| " | " | 23.6 | " | " | 15.5 | " | (Not mature) |
| " | " | 20.4 | " | " | 14.4 | " | |
| " | " | 21.2 | " | " | 14.6 | " | |
| C. A. S. 31,500 | " | 20.4 | " | " | 14.6 | " | |
| " | " | 17.1 | " | " | 12.2 | " | |

At Locality 31,500 two smaller shells of beehive shape with a small umbilicus were collected, which appear to belong to a different race. Both were dead "bones," badly worn, giving no opportunity to tell more than that they are double-banded shells measuring:

Diameter, 15.4 mm.; height, 12.3 mm.
Diameter, 15.4 mm.; height, 10.8 mm.

This extension of the range of *goniogyra* would seem to place this subspecies of *strigosa* above the level of a mere locality variation.

## **Polygyrella polygyrella** (Bland and Cooper)

*Polygyrella polygyrella*, Henderson, 1921, p. 86, fig. 43;—Pilsbry, 1939, p. 558, fig. 370.

Shells of this species were collected as follows:

C. A. S. 31,496 Lava slide 2 mi. east of Kooskia, Idaho Co., Idaho. Eleven adults, eighteen immature specimens. Diameter, 8.5-9.3 mm.; whorls 6⅞-7¼.

C. A. S. 31,498 25 mi. east of Kooskia. Fifteen adults, four immature. Diameter, 9.9-11.9 mm.; whorls, 7¾-8½.

C. A. S. 31,499 Meadow Cr., 1½ mi. south of Selway Falls. Sixty-one adults, thirty-one immature. Diameter 9.0-10.5mm.; whorls, 7¼-8⅛.

C. A. S. 31,500 4½ mi. southwest of Selway Falls. Six adults, seven immature. Diameter, 8.7-9.8 mm.; whorls 7⅛-8.

In general, shells from Idaho are slightly smaller, darker, and have a less prominent parietal tooth than those from the Bitterroot Mountains of Montana. Except in size, the Idaho lots collected by the expedition show no particular variations.

## Family POLYGYRIDAE

### Triodopsis mullani magnidentata Pilsbry

*Triodopsis mullani magnidentata* Pilsbry, 1940, p. 862, fig. 499, f, f'.

In a lava slide two miles east of Kooskia, along with two large-sized specimens of *T. mullani olneyae* (Pilsbry), two specimens of this small subspecies were taken. One, a dead shell, shows the strong tooth characters; the other, which is a younger shell, does not have the teeth fully developed. Measurements are:

Diameter, 9.9 mm.; height, 5.2 mm.; whorls, 5.
Diameter, 10.0 mm.; height, 5.1 mm.; whorls, 4¾.

This is a considerable extension of range for the subspecies, the original lot (the only one known) having been found by H. B. Baker near Cul-de-Sac, Nez Perce County, Idaho ("Mission Creek, 7 or 8 miles above Jaques Spur").

### Triodopsis mullani olneyae (Pilsbry)

*Triodopsis mullani olneyae,* Pilsbry, 1940, p. 864, figs. 499:i-1.

Shells of the *mullani* group were taken at four collecting stations visited by the expedition. Practically all specimens appear to be closest to *olneyae*, although in the two lots from near Selway Falls there is considerable variation, a fact not unusual in the group. The following lots were collected:

C. A. S. 31,496 2 mi. east of Kooskia, Idaho Co., Idaho. Two adults; nine immature specimens.

C. A. S. 31,498 25 mi. east of Kooskia. Four adults.

C. A. S. 31,499 Meadow Creek, 1½ mi. south of Selway Falls. One hundred twenty-three adults; fifty-two immature.

C. A. S. 31,500 4½ mi. southwest of Selway Falls. Twenty adults; twelve immature.

Adults from the first two of the above localities average about 17 mm. in diameter, but in the lots from near Selway Falls the size is extremely variable, as may be observed from the following measurements:

| | | |
|---|---|---|
| C. A. S. 31,500 | Diameter, 17.7; height, 10.2 mm. | Largest. |
| | Diameter, 11.9; height, 6.1 mm. | Smallest. |
| C. A. S. 31,499 | Diameter, 15.4; height, 8.0 mm. | Most depressed. |
| | Diameter, 17.3; height, 11.0 mm. | Most elevated. |

Among the shells from Selway Falls, depressed specimens are rare. Except for the smaller umbilicus, they are close to *T. mullani clappi* (Hemphill) found farther to the south along the Little Salmon River near Lucile and Riggins, in Idaho County, although reported also from Orofino, in Clearwater County.

The surface of the shells is variable, ranging from a matte or semi-matte to highly polished. Under a magnification of × 14 few of the duller shells show hair scars and on an occasional adult specimen a few of the hairs themselves can still be seen. These are features not found on the polished shells. The matte surface, with its hair scars and occasional hairs, is very thin and apparently is easily worn off by the movement of the snail in crawling, thus exposing the polished surface underneath. Why some fully adult shells should be polished and others not is a question that cannot be answered without greater knowledge than we now have of the growth and development of the shells, and the effect of ecological conditions, particularly food and the amount of acid content in the soil.

Young shells are sparsely hirsute, but occasionally a young polished shell is found that apparently never has had any epidermal hairs except possibly in the nuclear stage. In unusually well preserved young specimens the hairs are short and more closely set than they are when the shells are closer to the adult stage. Apparently these are lost after the shells attain three or four whorls. In most half-grown shells the nuclear and two postnuclear whorls are polished. Fairly long sparsely-set hairs begin at the end of the third whorl (rarely appearing on the second) and persist in most specimens until the last whorl begins. At the stage of growth from this point until after the characteristic rolled lip is formed the hairs begin to break off, leaving scars in some shells where the matte surface is not entirely worn off.

The peristome of most of the specimens is strongly reflected and rolled back along the edge. The body whorl immediately behind it is deeply channeled. A basal lamella is present in all shells, which is typical for *olneyae*, although variable in shape and prominence. In some specimens the lamella terminates rather abruptly at its right end instead of merging evenly with the inner lip. In a number of shells this termination is decorated with a small tooth-like projection, as in typical *mullani*. In only one rather small shell from near

Selway Falls was an outer lip-tooth present. A strong parietal tooth, generally short and of a triangular pyramidal shape with a rounded top, is present in most specimens. In a few, this tooth is reduced to a weak ovate tubercle; in four or five specimens the parietal tooth is absent.

The umbilicus of a large proportion of the shells is small and open, but in many of the Selway Falls specimens this is partially covered by the basal reflection of the lip. None is imperforate.

The elevated form from the lots found near Selway Falls is almost a distinct race, separable from *olneyae*, in addition to the greater elevation of the spire, by the tumid body whorl, smaller half-covered umbilicus, subquadrate rather than semi-lunate aperture, narrower peristome, and more polished shell surface. In the lot from Meadow Creek, twenty-one out of one hundred twenty-three adults are of this elevated form; in the other lot from near Selway Falls about half are this form. Three adults and one immature specimen are milk-white albinos. Immature shells are sparsely hirsute and cannot be separated with assurance from the other form. The parietal tooth is usually weaker, and in four shells it is absent. In size, the major diameter ranges from 14.5 to 16.4 mm.; the height from 8.7 to 10.4 mm.; and the number of whorls from 5½ to 5¾. An average shell measures: diameter, 15.6 mm.; height, 10.1 mm. As intergrades with the other form of *olneyae* exist in both lots, the above account, rather than a formal description, will serve to call attention to this relatively minor variation in a general group of snails in which such "little races" appear to be the rule rather than the exception.

### **Allogona ptychophora** (A. D. Brown)

*Polygyra ptychophora*, HENDERSON, 1929, p. 84, fig. 41.
*Allogona ptychophora*, PILSBRY, 1940, pp. 887-891, figs. 509 g-n, 510, drawings 5, 6.
*Allogona ptychophora* form *castanea*, PILSBRY, 1940, pp. 890-891, fig. 509 g, h.

Snails of this common Idaho species were abundant. In the main, they were found crawling on the ground and over mossy rocks. The shells are rather thin-textured and medium-sized for the species, ranging from 17.5 to 22.2 mm. in diameter, and from 11.9 to 14.7 mm. in height. Transverse sculpture consists of many closely-spaced, low, sinuous ribs extending across the body whorl, with a spiral sculpture of fine, subobsolete striations. Traces of malleations occur on some specimens. On about one-third of them there is a trace of a basal tooth. The following lots were collected:

| | |
|---|---|
| C. A. S. 31,496 | In a lava slide, 2 mi. east of Kooskia, Idaho Co., Idaho. Three adults and several immature specimens. |
| C. A. S. 31,497 | 8½ mi. east of Kooskia, on a road to Selway Falls. Twenty-nine adults, three immature. |
| C. A. S. 31,499 | Meadow Cr., 1½ mi. south of Selway Falls. Forty-five adults, fifteen immature. |

All specimens of the medium-sized, thin-textured *ptychophora* collected by the expedition appear to belong to the race described as *Helix ptychophorus* var *castaneus* by Hemphill in 1890 and subsequently considered as a "form" by Pilsbry. In the Academy's Type Collection are six syntypes of the form *castanea* (Hemphill) from Rathdrum, Idaho (CAS 8136 H. H., nos. 1221–1226, incl.) and six additional syntypes from Old Mission, Idaho (CAS 8134 H. H., nos. 1227–1232, incl.). Also in the collection are six other lots comprising thirty-three shells from Spokane Falls, Washington; Weiser Canyon, Idaho; and from the banks of the Salmon River, Idaho. Comparison of expedition shells with these and with many lots collected by the late Rev. E. H. Ashmun and by the author, principally along the Weiser, Little Salmon, and Salmon rivers, brings to light no marked or constant differences. Small, heavily textured and generally light-colored shells collected with *Oreohelix idohoensis* (Newc.) one mile south of Lucile, Idaho, along a highly mineralized creek are the only exceptions observed although the conditions of their habitat are probably sufficient to result in this particular variation.

The name *castanea* is somewhat misleading. Many light-colored shells occur in freshly collected lots, although there is a larger ratio of dark-colored shells in the lots taken by the expedition. Hemphill's original lots from Rathdrum and Old Mission are now all generally light in color but may have been considerably darker when collected. One suspects that these shells may have faded considerably in the course of years. The name *castanea* might well be dropped as it does not appear to represent a race of *ptychophora* that can be easily separated from typical specimens, more particularly from the neotype collected near Ward, Montana (Pilsbry, 1940, p. 889, fig. 509, i. j.). *A. p. solida* (Vanatta) has definite and apparently constant characters that set it apart from the typical form. Although it is possible that the smooth form collected by H. B. Baker near Stites, Idaho (Pilsbry, 1940, p. 891, fig. 509, m, n.), might be a valid subspecies, more collecting in this vicinity would seem desirable to determine its range and limit of variation before such a step is taken.

As Pilsbry has given a full account of the anatomy of *ptychophora*, none of the animals collected was dissected. To his account may be added the existence of a considerable variation in the color of the mantle of the animal. There are three well marked color groupings: first, animals with a uniformly blue-black mantle; second, those with a whitish mantle strongly marked with irregular black spots or maculations; and third, those with a uniformly light cream-colored mantle marked with faint brownish areas. There is no evident connection between the mantle color of the animal and the hue of the shell, darkest colored shells more often having light or black-spotted animals than those of the blue-black color. In a series of thirty-two shells collected in June, 1941, at the south entrance of the

Weiser National Forest (AGS 7838), nine animals had the dark mantle, thirteen had a speckled mantle, and ten had the light-colored mantle. Corresponding shells in each group varied from light to dark.

The wide range of variation in *A. ptychophora* is interesting and the relative abundance of specimens within its territory ought to present no great difficulties in working it out completely. There still remain large uncollected areas, however, to cover.

### **Allogona lombardii** A. G. Smith, new species

PLATE 48, figs. 1 to 4

The shell is large and heavy, approximately the size and texture of medium-sized *A. townsendiana* (Lea), moderately elevated, with from 5⅝ to 6⅛ whorls, the last one tumid. Nuclear whorls one and one-half to two, glossy, smooth except for fine transverse ribbing in the vicinity of the suture. Umbilicus small, contained from ten to thirteen times in the major diameter of the shell. Sutures well impressed. Aperture semi-lunate, the peristome heavy, white, strongly reflected, the edge slightly rolled back. Some shells have a subobsolete basal tooth or short basal lamella near the columellar end of the peristome. Sculpture consisting of transverse sinuous ribs, most prominent on the body whorl, closely though variably spaced, and generally extending continuously across the whorls. Closely set, wavy, spiral striations, generally present above and below, are strongest near the summits of the whorls, although on many shells these striations are subobsolete. Malleations absent. Color ranging from a dark bistre-brown to a light buff-brown, shells of darker color predominating. Ridges of the transverse sculpture in the darker specimens are light buff, serving to set them off in a most striking manner from the darker ground-color of the shell. Surface of fresh shells shining but not highly polished.

*Holotype:* C. A. S. Paleo, Type Collection, No. 7893, Major diameter, 27.0 mm.; height, 19.0 mm.; whorls, 5¾.

Type Locality: C. A. S. Locality 31,499, along **Meadow Creek, 1½ m. south of Selway Falls, Idaho Co., Idaho,** elevation 1900 feet. In addition to the holotype, seventy-three adult and seven immature specimens were collected.

*Paratypes:* Specimens from the type locality so designated have been deposited in the Academy's Paleo. Type Collection (Nos. 7894 to 7898, incl.); in the collections of the Academy of Natural Sciences of Philadelphia, the U. S. National Museum, Stanford University, the Los Angeles Museum, the San Diego Society of Natural History; and the private collections of Mr. and Mrs. Emery P. Chace, S. S. Berry, and A. G. Smith.

*Other Localities:* C. A. S. Locality 31,500, 4½ mi. southwest of Selway Falls, Idaho Co., Idaho, at an altitude of 5,800 feet, a total of eleven adult and three immature specimens.

*Remarks:* At both localities where this remarkable snail was collected it was found along with the race of *A. ptychophora* just discussed. No intergrades between the two were taken, and because the shells of the large, robust, heavily-ribbed form present so different an aspect, it is given status as a separate species.

Compared with *A. townsendiana* (Lea), a snail found only in humid coastal region west of the Cascade Mountains, it is about equal in heavy shell texture and nearly equal in size. Also, it is more elevated, has a smaller umbilicus, more prominent transverse sculpture, and differs further in the complete lack of malleations.

The shells of *lombardii* tend toward a relatively elevated spire, only five out of a total of twenty on which specific notes were made having the spire depressed. In this same group of twenty, the basal tooth is subobsolete in nine shells, in two the tooth is quite strong, while in the remaining eleven shells there is hardly a suggestion of a tooth or none at all.

In older shells the epidermis, which is thin, becomes worn off. In senile specimens often there is hardly any of it left. Two or three extremely light yellowish specimens, possibly xanthic, were taken, one being the largest shell in the following table of measurements, which demonstrates the range in size of the species:

| | *Maj. Diam.* | *Height* |
|---|---|---|
| Largest | 29.2 mm. | 18.6 mm. |
| Most elevated | 24.8 " | 18.1 " |
| Most depressed | 28.0 " | 17.8 " |
| Smallest | 24.2 " | 16.9 " |
| Average of 20 | 26.6 " | 18.5 " |

Spacing of the transverse ribbing is quite variable, being as small as 0.5 mm. in some shells to 1.0 mm. in others, while occasional spacing of as much as 1.6 mm. occurs. On individual specimens a considerable difference in rib spacing exists. All ribs are not continuous across the body whorl and in some shells occasional ribs begin well below the suture and even at the periphery. Some ribs are broken and in others a tendency towards branching may be noted, although these are minor sculptural features.

Very young shells of *lombardii* cannot be separated for sure from the young of *ptychophora.* This can be done, however, when the snails are about one-quarter grown, when the heavier texture and the more prominent ribbing of the former begin to develop.

By all odds, *Allogona lombardii* is the most heavily ribbed of any of the large number of lots of the western Allogonas examined. Approaching it in type of sculpture, but not in size, is a lot of six shells from Boswell, Kootenay Lake, British Columbia (C. A. S. 27,064), which probably should take the same name.

It is a pleasure to name this new and striking addition to our West Coast mollusk fauna in honor of Mr. M. E. Lombardi, whose interest and very material help made possible the Academy's recent expedition into a little-known region in the mountains of Idaho.

## SAGDIDAE

### **Microphysula ingersollii** (Bland)

*Microphysula ingersollii*, HENDERSON, 1929, p. 90, fig. 46;—PILSBRY, 1940, p. 991, figs. 579, A, B, C.

Shells of this species were picked from leaf mold as follows:

C. A. S. 31,496 Lava slide, 2 mi. east of Kooskia, Idaho Co., Idaho. Two adult specimens.

C. A. S. 31,500 Meadow Creek, 1½ mi. south of Selway Falls, Idaho. One immature specimen.



## COCHLICOPIDAE

### **Cochlicopa lubrica** (Müller)

*Cochlicopa lubrica*, HENDERSON, 1929, p. 94, fig. 55.

About thirty immature specimens were found in the leaf-mold along Meadow Creek, 1½ miles south of Selway Falls (C. A. S. 31,499). Careful search of the ground-cover failed to produce adult shells. As this species is not uncommon in the Idaho region it is difficult to account for its apparent scarcity at the expedition's collecting stations, unless it be a lack of lime in the soil.

## ZONITIDAE

### **Zonotoides arboreus** (Say)

*Zonotoides arboreus*, BAKER, H. B., 1928, p. 39, pl. 8, figs. 6-9 (for anatomy);—HENDERSON, 1929, p. 102, fig. 65 (for synonymy).

C. A. S. 31,496 Lava slide, 2 mi. east of Kooskia, Idaho Co., Idaho. One adult, one immature specimen.

C. A. S. 31,498 25 mi. east of Kooskia. Two adult specimens.

C. A. S. 31,499 Meadow Creek, 1½ mi. south of Selway Falls, Idaho Co., Idaho. Five adult specimens.

## ARIONIDAE

### **Hemphillia camelus** Pilsbry and Vanatta

*Hemphillia camelus* Pilsbry and Vanatta, 1898, pp. 234, 235; pl. 9, figs. 3, 4; pl. 12, figs. 41, 42; pl. 16, fig. 85.

This was the commonest slug collected by the members of the expedition and a large series from young to fully adult specimens was taken. The species was found more abundantly on Meadow Creek, around 1,900 feet elevation, than higher in the mountains. Hemphill has reported on the curious propensity of this slug to whip its tail violently from side to side when disturbed, which Dr. Hanna also stated was true from his experience while collecting it in Idaho. This brings to mind a remark, made to the author many years ago by P. B. Randolph, of Seattle, that *Hemphillia* could actually jump a short distance by a quick flexure of its tail.

According to Dr. Hanna, *Hemphillia* was collected frequently in the vicinity of traps set for the capture of small mammals, sometimes being found crawling on a mouse or shrew that had been caught. Camp refuse placed to attract slugs generally failed to draw them but the species did appear to show a fondness for orange peel.

Until positive identification is established by dissection of the animals, all specimens of *Hemphillia* collected by the expedition are referred to *camelus* rather than to *glandulosa*, its congener that has so far apparently been found only west of the Cascade Mountains. The following lots have been placed in the Academy's collection:

C. A. S. 31,499 Meadow Creek, 1½ miles south of Selway Falls, Idaho Co., Idaho. Between thirty and forty specimens of all ages, sealed in alcohol in two test-tubes.

C. A. S. 31,500 4½ miles southwest of Selway Falls. Two adult and one half-grown specimens also preserved in alcohol.

In addition to the above lots, the Academy has the following lots *Hemphillia* in its alcoholic collection:

C. A. S. 11,653 *H. glandulosa* Binney and Bland. Syntypes Nos. 2239 to 2254, inclusive. A series of seventeen small individuals from Astoria, Oregon, the label marked "original lot" and "Types" in Hemphill's handwriting.

C. A. S. 11,652 *H. glandulosa* Binney and Bland. Kalama, Wash. One very large specimen collected by Henry Hemphill.

C. A. S. 28,093 *H. glandulosa* Binney and Bland, Olympia, Wash. Eighteen specimens (including only three full-grown or nearly so) collected by Henry Hemphill.

C. A. S. 11,654 *H. camelus* Pilsbry and Vanatta. Near Old Mission, Idaho. Six topotypes, probably from the original lot, collected by Henry Hemphill.

C. A. S. 31,788 *H. camelus* Pilsbry and Vanatta. Old Mission, Idaho, or Coeur d'Alene, Idaho. About fifteen specimens collected by Hemphill.

C. A. S. 31,748 *H. camelus* Pilsbry and Vanatta. Near Stites, Idaho. Seven full-grown specimens collected by Hemphill.

C. A. S. 28,077 *H. camelus* Pilsbry and Vanatta. Slate Creek, Idaho Co., Idaho. Twelve adult specimens collected by Hemphill.

C. A. S. 31,743 *H. camelus* Pilsbry and Vanatta. Slate Creek, Idaho Co., Idaho. Four adult specimens collected by Hemphill.

These lots are still in a fair to good state of preservation, in spite of having been collected in 1889 or earlier.

### **Prophysaon andersoni** (J. G. Cooper)

*Prophysaon andersoni*, Pilsbry and Vanatta, 1898, pp. 245-248; pl. 10, figs. 18-22; pl. 11, figs. 28, 29; pl. 13, figs. 59-62; pl. 16, figs. 92, 93.

Slugs of the genus *Prophysaon*, which are provisionally assigned to this species, were collected at two localities. They did not appear to be at all common.

C. A. S. 31,499 Meadow Creek, 1½ mi. south of Selway Falls, Idaho Co., Idaho. Four medium-sized individuals preserved in alcohol.

C. A. S. 31,500 4½ mi. southwest of Selway Falls. Four specimens preserved in alcohol.

Confirmation of the identification of these slugs must await dissection of the animals. In the Academy's alcoholic collection is a lot of three that appear to be this same species. They were collected by Henry Hemphill near Stites, Idaho (C. A. S. 31,747).

### **Zacoleus idahoensis** Pilsbry

*Zacoleus idahoensis* Pilsbry, 1903, pp. 626-629, pl. 28, figs. 1-11.

This little-known small black slug was described from specimens sent to Dr. Pilsbry by the Rev. E. H. Ashmun, who collected it, apparently in quantity, at Meadows, Washington Co. (now Adams Co.), Idaho. Although confirmation must depend upon dissection, specimens of what are almost certainly this species were collected by the members of the Academy's expedition as follows:

C. A. S. 31,499 Meadow Creek, 1½ mi. south of Selway Falls, Idaho Co., Idaho. Three specimens preserved in alcohol.

C. A. S. 31,500 4½ mi. southwest of Selway Falls. Three specimens preserved in alcohol.

The Academy's alcoholic collection contains the following additional lots that are provisionally referred to this species:

C. A. S. 31,544 Meadows, Adams Co., Idaho. About twenty-five specimens, probably topotypes from the original lot, collected around 1900 by E. H. Ashmun.

C. A. S. 31,511 Meadows, Adams Co., Idaho. Another lot of thirty to forty topotypes, possibly from the original lot collected by Ashmun.

C. A. S. 31,546 Weiser, Idaho. Two specimens collected by Ashmun.

C. A. S. 31,549 2 mi. south of Tamarack, Adams Co., Idaho. One specimen collected by A. G. Smith, June 3, 1941.

## ENDODONTIDAE

### Anguispira kochi (Pfeiffer)

***Anguispira kochi occidentalis*** Martens, HENDERSON, 1929, p. 112, fig. 77.
***Anguispira kochi kochi***, MACMILLAN, 1940, p. 394, pl. 40, figs. 2, 3.

Common around Selway Falls, being taken crawling on mossy rocks and vegetation along with *Allogona ptychophora*, *A. lombardii*, *Triodopsis mullani olneyae*, and *Anguispira nimapuna*.

C. A. S. 31,499 Meadow Creek, 1½ mi. south of Selway Falls, Idaho Co., Idaho. Twenty-nine adults, forty-four immature specimens.

C. A. S. 31,500 4½ mi. southwest of Selway Falls. Seven adults, four immature specimens.

From the first-listed locality fully-grown shells were fairly large and show considerable variation in the height of the spire. Sample measurements are:

Diameter, 25.2; height, 18.2 mm. (moderately elevated)
Diameter, 23.9; height, 19.0 mm. (elevated)
Diameter, 26.3; height, 17.6 mm. (depressed)

Shells from Locality 31,500 are smaller, probably due to the less favorable conditions found at the higher altitude. The largest shell in this lot has a diameter of 18.9 mm., and a height of 13.5 mm.

MacMillan states that the range of *kochi* extends "west to California and north to Southwestern British Columbia." This should be clarified, for specimens are not known to have been collected in California, or west of the Cascade Mountains in the Pacific Northwest. It has not been reported from Nevada or Arizona. It is common in suitably forested areas in Idaho, eastern Oregon, and eastern Washington at least as far west as Spokane.

### **Anguispira nimapuna** H. B. Baker

*Anguispira nimapuna* BAKER, 1932, p. 82, pl. 5, figs. 4-6;—MACMILLAN, 1940, p. 391, pl. 38, figs. 7, 8.

A large series was collected by the expedition near Selway Falls, where it was common crawling over mossy rocks in the moist weather. Identification is made certain by comparison with paratypes furnished the Academy by Dr. Pilsbry.

| | |
|---|---|
| C. A. S. 31,498 | 25 mi. east of Kooskia, Idaho Co., Idaho. One full-grown large (but dead) adult specimen. |
| C. A. S. 31,499 | 1½ mi. south of Selway Falls, Idaho Co., Idaho, along Meadow Creek. One hundred sixty adults, one hundred thirteen immature specimens. |
| C. A. S. 31,500 | 4½ mi. southwest of Selway Falls. Six adults, ten immature specimens. |

Measurements of three shells from C. A. S. 31,499 give the extremes in size and shape:

| | *Diameter* | *Height* | *Height (not including aperture)* |
|---|---|---|---|
| Largest | 14.5 mm | 6.0 mm. | 4.0 mm. |
| Most elevated | 13.3 " | 7.0 " | 4.0 " |
| Most depressed | 12.7 " | 5.0 " | 3.6 " |

Before these shells were collected by the expedition, *A. nimapuna* was known only from the type locality near Stites, in northwestern Idaho County, Idaho.

### **Discus cronkhitei** (Newcomb)

*Discus cronkhitei cronkhitei*, HENDERSON, 1929, p. 113, fig. 78;—MACMILLAN, 1940, p. 405, pl. 39, figs. 15, 16.

A single specimen, found 4½ miles south of Selway Falls, Idaho County, Idaho, is not different from those found commonly in the mountains of northern California and at several Oregon localities, with which it was compared.

### **Helicodiscus salmonensis** Hemphill

*Helicodiscus salmonensis*, PILSBRY and FERRISS, 1906, p. 157;—HENDERSON, 1929, p. 114, fig. 80;—HANNA, 1939, p. 301, pl. C, figs. 11-13.

A single specimen was taken in a lava slide, 2 miles east of Kooskia, Idaho County, Idaho (CAS 31,496).

### **Punctum randolphii** (Dall)

*Pyramidula ? randolphii* DALL, 1895, p. 130.
*Punctum randolphi*, HENDERSON, 1929, p. 117, fig. 84.

But one specimen of this minute species was collected in leaf mold 4½ miles southwest of Selway Falls, Idaho County, Idaho. Comparison was made with a topotype collected by P. B. Randolph at Seattle (AGS 7087).

### **Radiodiscus abietum** H. B. Baker

*Radiodiscus abietum* BAKER, H. B., 1930, p. 124, pl. 6.

This little-known species is limited to Idaho, so far as is known. The expedition collected it at three localities:

| | |
|---|---|
| C. A. S. 31,496 | Lava slide, 2 mi. east of Kooskia, Idaho Co., Idaho. Three adult specimens. |
| C. A. S. 31,499 | Meadow Creek, 1½ mi. south of Selway Falls, Idaho Co., Idaho. Six adults, six immature specimens. |
| C. A. S. 31,500 | 4½ mi. southwest of Selway Falls. Three adult specimens. |

Comparison of shells from the above lots were made with a series collected by H. B. Baker collected on John Day Creek in Idaho County, and placed in the Academy's collection for this purpose through the courtesy of Dr. H. A. Pilsbry of the Academy of Natural Sciences of Philadelphia.

## PELECYPODA: MARGARITIFERIDAE

### **Margaritifera margaritifera falcata** (Gould)

*Margaritifera margaritifera falcata*, HENDERSON, 1929, p. 53, fig. 1.

One specimen was collected from Meadow Creek, 1½ miles south of Selway Falls, Idaho County, Idaho (CAS 31,499).

## SPHAERIIDAE

### **Pisidium** (species?)

*Pisidium* (various species), HENDERSON, 1929. pp. 66-71, figs. 19-27.

Twenty specimens of a small representative of this genus were collected in Meadow Creek, 1½ mi. south of Selway Falls (CAS 31,499).

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PLATE 48

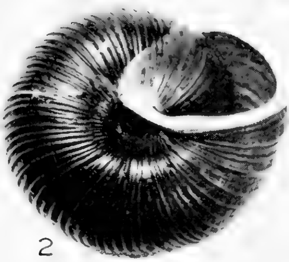
Fig. 1.—*Allogona lombardii* A. G. Smith, new species, Holotype No. 7893, (Calif. Acad. Sci. Paleo. Type Coll.), from Loc. 31499 (C.A.S.), along Meadow Creek, 1½ miles south of Selway Falls, Idaho County, Idaho, elevation 1900 feet. Major diameter, 27.0 mm.; height, 19.0 mm.; whorls, 5¾. Apertural view.

Fig. 2.—*Allogona lombardii* A. G. Smith, new species. Basal view of specimen shown in Fig. 1.

Fig. 3.—*Allogona lombardii* A. G. Smith, new species. Apical view of specimen shown in Fig. 1.

Fig. 4.—Moist forest undergrowth and litter in which *Allogona lombardii* occurred, 3 miles southwest of Selway Falls, 5500 feet elevation, Idaho County, Idaho. Photograph taken September 19, 1941.

1



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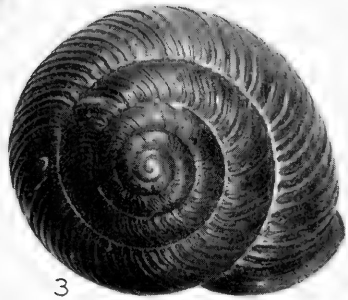

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**PROCEEDINGS**

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## No. 37

# CLASSIFICATION OF THE ERMINES OF EASTERN SIBERIA

BY

E. RAYMOND HALL

*Museum of Vertebrate Zoology*
*University of California*

To ascertain if the ermine (*Mustela arctica* Merriam) of North America was more than subspecifically different from the ermine (*Mustela erminea* Linnaeus) of the Old World, I borrowed, in 1937 at the Leningrad Academy of Sciences, through the courtesy of Professor B. S. Vinogrodov and Anatol I. Argyropulo, selected pertinent specimens from eastern Asia, for study in America. Although comparisons make clear, as I shall explain in a later paper treating of all of the American forms of the subgenus *Mustela*, that a single circumpolar species is involved, there appears to be some confusion about the subspecific names for this weasel in eastern Asia. The purpose of the present communication is to clear away this confusion.

*Mustela erminea* Linnaeus 1758 is the earliest available name and therefore it will apply for the full species. In 1857, Baird (Mammals of North America, p. 172) proposed for the ermine of extreme eastern Asia the name *Putorius kaneii*. The two specimens that he had came from Semipalatinsk, Siberia, and Arikam Island, Bering Strait. Application of current rules of nomenclature to Baird's original description (*loc. cit.*) indicates that Arikam Island is the type locality.

This name was not considered by J. A. Allen when he reported under the name *Putorius* (*Arctogale*) *ermineus* specimens from eastern Siberia resulting from the Jesup North Pacific Expedition

August 22, 1944

(Bull. Amer. Mus. Nat. Hist., vol. 19, p. 174, 1903) but was correctly applied by G. M. Allen (Proc. New England Zool. Club, vol. 5, p. 58, 1914) to specimens from Nijni Kolymsk.

In 1928, Ognev (Memuary Zoologicheskov otdelenia obshchevstva lyubiteli estestvoznania, vol. 2, p. 15) proposed the name *Mustela erminea orientalis* for the ermine of eastern Siberia, choosing as his type specimen one from Village Pokhodskoe on the Kolyma River (69° 04′ N, 160° 55′ E), which like Nijni Kolymsk is near the mouth of the Kolyma River. Apparently Ognev overlooked, or was unaware of the application of, Baird's earlier proposed name for the only reference that he makes to it, so far as I can find in his published writings, is in the synonymy of *Mustela erminea orientalis* in his "The Mammals of USSR and Adjacent Countries" (vol. 3, p. 33, 1935). There Ognev lists "1914 *Mustela kanei* Allen, Gl., . . . ."

Fortunately, the United States National Museum contains a good representation of *Mustela erminea* from the region of the mouth of the Kolyma River, particularly from Nijni Kolymsk, obtained in 1915 by C. Armory, Jr. These practical topotypes of *M. e. orientalis* in comparison with the material used by Baird as basis for his name *kaneii* reveal no differences judged to be of systematic worth. Of course, certainty as to the subspecific identity of ermines from the mainland of Asia with those from Arikam Island can be felt only when adequate topotypes are available from the island; the type of *kaneii* which is the only available specimen from the island clearly is of the species *Mustela erminea* and is indistinguishable in color from other Siberian ermines. The animal is young and, on this account and because the postmolar parts of the cranium and lower jaws are lacking, no cranial characters of subspecific worth are provided. My conclusion is that, in the present state of knowledge, the name proper to apply to the ermine of eastern Siberia with geographic range as outlined by Ognev (*op. cit.*, 1935, p. 33, and map 1 on p. 41) is:

### **Mustela erminea kaneii** (Baird)

*Putorius kaneii* Baird, Mammals of North America, p. 172, 1857.

*Type.*—Male, young, skin with skull; no. $\frac{2330}{37990}$, U. S. Nat. Mus.; Arikam Island, Bering Sea, Siberia; previous to March, 1857; obtained by W. Stimpson; original no. 358.

The skin is in a good state of preservation. The postmolar parts of the cranium and lower jaws are gone. Open sutures between the bones on the upper face of the rostrum clearly show the specimen to be young. The teeth all are present. $M_1$ is 5.4 mm. long. $P^4$ measures 4.8 on the lateral side and 5.0 on the medial side. These measurements are larger than recorded for any female and are nearer those of small males.

*Range.*—Eastern Siberia, Kamchatka excepted, from the Polar seas south to about 60° N and from Bering Strait westward to the River Lena or farther.

*Diagnosis.*—Size medium, see measurements; in full winter pelage black tail-tip averaging 88 per cent of length of tail-vertebrae; skull relatively flat and broad.

*Comparisons.*—From *M. e. ognevi* Jurgenson 1932, the race to the westward, known to me by adequate material from the Turkhansk district, *kaneii* differs, as pointed out by Ognev (The Mammals of the USSR. . . ., vol. 3, p. 28, 1935) in smaller skull, that is more flattened (shallower) in both facial and parietal regions. The remaining differences recorded by Ognev (*loc. cit.*) are not apparent with our material; indeed the tooth rows in specimens from Nijni Kolymsk are shorter, instead of longer than in those of *ognevi*. From *M. e. arctica* of Alaska (topotypes and specimens from Tanana) skulls of *kaneii* differ as follows: smaller; relatively, as well as actually, narrower except in mastoidal region where relatively (to basilar length) the width is more; preorbital part of skull shallower as well as narrower. From *M. e. digna*, *kaneii* differs as follows: skull broader, actually as well as relatively; waist of interorbital constriction shorter; tooth rows and tympanic bullae relatively as well as actually shorter. Lack of specimens of *M. e. transbaikalica* and *M. e. baturini*, races whose geographic ranges meet that of *kaneii* on the south, prevents my adding anything to what Ognev (*op. cit.*) has written.

*Remarks.*—In making cranial comparisons, care has been taken to use specimens of comparable age and sex. In the table of measurements the adult males there recorded are of comparable age (more than one year old) and any one lot of subadults is of about the same age as any other excepting the lot from Nijni Kolymsk, the animals from which place average about 6 weeks younger than subadults from the other places. This lesser age explains in part, but by no means entirely, why certain measurements of width of the skull are smallest in the subadults from Nijni Kolymsk.

The subspecies (geographic races) here recognized are not strongly differentiated—nowhere nearly as well marked as are the races of *Mustela frenata*—and all the differences detected are in the skull. If ideally abundant material was available, external measurements (length of body, tail, hind foot and ear) might provide some differences useful in distinguishing subspecies but the differences would be slight. Study of the coloration reveals nothing that I judge to be other than individual variations or variations that owe their existence to differences in ontogeny.

By thus commenting on the slight (relative to *M. frenata*) racial distinctions I do not intend to imply that study of additional material will not reveal true geographic variations in *Mustela erminea* of eastern Asia, conceivably requiring further subspecific separation. Among the specimens here assigned to *M. e. kaneii* there appears to be some geographic variation. Those from Nijni Kolymsk near the mouth of the Kolyma River are not exactly like specimens from Vassiliev, 450 miles to the eastward and about 40 miles north of the estuary of the Anadyr River; the skulls of ermines from Vassiliev average larger, particularly in length of upper tooth rows and larger tympanic bullae.

*Measurements.*—Cranial measurements are given in the table at the end of this paper. External measurements, by the collector, of 2 adult males from Nijni Kolymsk and a subadult (slightly less than one year old) female from Pontilayha Kolymsk, are as follows: Total length, ♂, 341, 367, ♀, 287; length of tail vertebrae, 89, 95, 65; length of hind foot, 43, 51, 36 (in the dry state including the longest claw the hind feet measure 41.4, 47.5, 32.5).

*Specimens examined.*—Total number, 61. Localities are arranged from west to east. Unless otherwise indicated, specimens are in the collection of the Leningrad Academy of Sciences. Mouth of Lena River, 2; Miaktchirge Island, 1; Sabo-Sitsch [g?]e Island, 1; Aldan River, 25 verst from Iskutsk, 1; Tulara River, right tributary of Aldan River, 1; Arylach on Aldan River, 1; Uly-Tymyl Station, near source of Iana River, 1; village of Kytylyn-Sebyt near junction of Tyssy-Iurach and Dulgalacha rivers, 1; Buluguniachtach 60 kilometers from Verkhoiansk on Dulgalacha River, 1; Adytscha River on Kolym Trail, 1; village of Chabatschi on Adytscha River, 25 kilometers south of the station of Adytschenskaia, 2; station of Tostach on Tostachai River near its junction with Adytscha River, 1; Verkhoiansk River, Kanso-Uriach right tributary of Iana River, 80 kilometers north of the city of Verkhoiansk, 1; settlement of Sylgytyr, Jakutsk District, 11; village of Kasatschi, in region of Iakutsk, 1; mouth of Moma River, 1; village of Allaicha, valley of Indigirka, 9; Nijni Kolymsk, 10 (U. S. Nat. Mus.); Pontilayha Kolymsk, 2 (U. S. Nat. Mus.); Anadyr District, 1; Osselkino, near Markova, Anadyr River, 1; Aljtat-Kuulj River, Anadyr estuary, 1; botanical garden at Vassiliev, 8; village of Medro [nipot?], Chukotsk Peninsula, 1.

Ognev (*op. cit.*, pp. 31-33) pointed out cranial differences between ermines from Kamchatka and those from the mainland, but with inadequate Alaskan material was unable to differentiate the animal from Kamchatka from *Putorius arcticus* Merriam with type locality at Point Barrow, Alaska. He recognized that the ermine of Kamchatka might be an unnamed subspecies, being of the opinion that adequate series of skins—which he lacked—from Alaska and Kamchatka would show the animal from the latter place to be paler. In the absence of skins from Kamchatka I can offer no opinion about the color but the 9 skulls from the Leningrad Academy of Sciences, labeled merely as Kamchatka, and taken by Grebnitzsky in 1864 or

1884, clearly are subspecifically distinct from topotypes and other Alaskan specimens of *Putorius arcticus* Merriam. For the ermine of Kamchatka, I propose the name:

### **Mustela erminea digna** Hall, subspecies nova

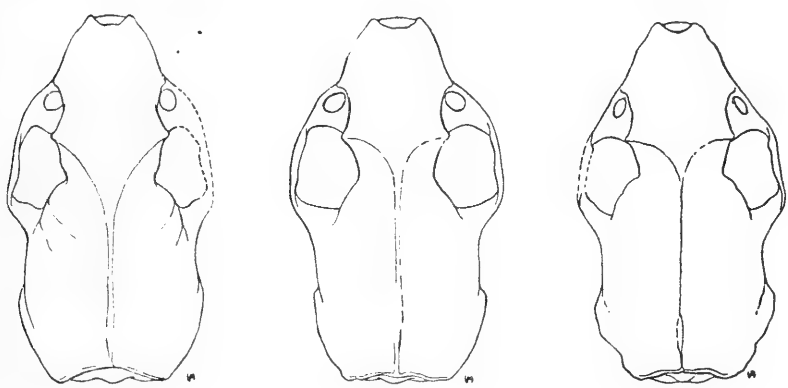
*Type.*—Male, adult, skull-alone, no. 5703, Leningrad Academy of Sciences; Kamchatka, Asia; obtained by Grebnitzsky, in 1884 or 1864.

*Range.*—Kamchatka.

*Diagnosis.*—Skull long and slender; waist of interorbital constriction long; tympanic bullae moderately inflated; length of upper tooth rows more than orbitonasal length.

*Comparisons.*—From the skull of *M. e. arctica*, that of *digna* differs in longer tooth row, lesser breadth in all parts measured except the tympanic bullae which are the same, and in the smaller preorbital part of the skull. From *M. e. kaneii*, *digna* differs in the longer (relatively as well as actually) tympanic bullae, narrower and longer skull and more waistlike postorbital constriction.

*Specimens examined.*—Total number 9 skulls-alone, from Kamchatka.



*a* *b* *c*

Fig. 1. Dorsal views of the skulls of three adult males of three subspecies of *Mustela erminea*. Natural size.
*a*. *Mustela erminea kaneii* (Baird), Catalogue No. 17763, Leningrad Acad. Sci., from Vassiliev, Siberia.
*b*. *Mustela erminea digna* Hall, subspecies nova, Catalogue No. 5703, Leningrad Acad. Sci., from Kamchatka, Siberia.
*c*. *Mustela erminea arctica* (Merriam), Catalogue No. 10012, U. S. Nat. Mus., from Point Barrow, Alaska.

Cranial Measurements, in Millimeters, of Males of Three Subspecies of *Mustela erminea*

| | *digna*, 4 adults, Kamchatka | *digna*, 5 subadults, Kamchatka | *kaneii*, 2 adults, Nijni Kolymsk | *kaneii*, 7 subadults, Nijni Kolymsk | *kaneii*, 8 subadults, Vassiliev | *arctica*, 5 adults, Point Barrow, Alaska |
|---|---|---|---|---|---|---|
| Basilar length (of Hensel) | 43.1 | 41.9 | 41.3 | 39.7 | 42.6 | 42.5 |
| Length of tooth rows | 15.9 | 15.2 | 15.1 | 14.2 | 15.3 | 15.7 |
| Breadth of rostrum on outside of lacrimal processes | 14.8 | 13.8 | 14.6 | 13.2 | 14.2 | 15.3 |
| Least interorbital breadth | 11.5 | 11.3 | 11.6 | 10.4 | 11.4 | 12.5 |
| Orbitonasal length (anterior nares to tip of left postorbital process) | 14.9 | 15.0 | 15.6 | 14.2 | 15.3 | 16.0 |
| Mastoid breadth | 22.7 | 22.3 | 23.0 | 21.7 | 23.3 | 23.3 |
| Zygomatic breadth | 27.4 | 25.8 | 26.0 | 24.5 | 26.6 | 27.5 |
| Length of tympanic bulla | 14.8 | 13.2 | 15.4 | 14.2 | 15.4 | 15.3 |
| Breadth of tympanic bulla (median side to pit for hyoid) | 8.4 | 8.1 | 8.5 | 8.0 | 8.6 | 8.3 |
| Length of $M_1$ | 5.7 | 5.5 | 5.6 | 5.3 | 5.6 | 5.8 |
| Breadth of $M^1$ | 3.9 | 3.9 | 3.9 | 3.7 | 4.0 | 4.1 |
| Depth of skull at posterior borders of $Ms^1$, through plane of postorbital processes | 12.4 | 11.9 | 12.1 | 11.5 | 12.4 | 13.1 |

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# NOTES ON SOME UNFIGURED TYPE-SPECIMENS OF CHINESE MOLLUSKS FROM THE NORTH PACIFIC EXPEDITION

BY

TENG-CHIEN YEN*

The North Pacific Exploring Expedition was carried on from June, 1853, to October, 1855, by the U. S. S. "Vincennes", at first under Captain Ringgold, and after August, 1854, under Captain Rodgers. William Stimpson was the official Zoologist and did most of the collecting work. The ship was for some time stationed at Hong Kong and cruised to Macao and along the Pearl river up near Canton. In these regions most of the Chinese molluscan specimens were obtained, but those localities given as "China Seas" and "Coast of China" generally indicate the open sea, Lat. 21° 52′ N. and Long. 114° 09′ E. to Lat. 22° 25′ N. and Long. 123° 53′ E. which the ship passed through on her way to Japan.

The molluscan collection of this expedition was studied by A. A. Gould, and his results were published successively in the "Proceedings of the Boston Society of Natural History", from 1859 to 1861, and reproduced in 1862 as the third part of his "Otia Conchologica". However, in neither of these publications were his new species from this expedition illustrated. A few of them were subsequently figured by Sowerby in Reeve's "Conchologia Iconica", and some by Watson in the "Report on the Scientific Results of the Voyage of H. M. S. Challenger....Zoology, Vol. 15, Pt. 42." But these illustrations were not taken from the specimens of the original lots.

Gould's report on the result of this expedition was an important one in Chinese malacology, not only because of its early date of pub-

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lication, but also because of the great number of species contained therein. No fewer than 122 species were proposed as new to science. Since then the regions where Stimpson's material was obtained, were repeatedly explored, and studied by naturalists abroad as well as at home in subsequent years, and many of Gould's species were neglected and duplicately named, possibly due largely to the brief original descriptions without illustrations. A few cases of these can be cited here as examples: *Columbella* (*Amycla*) *planaxiformis* Sowerby, 1894, is *Columbella bicincta* Gould, 1860, *Minolia* (*Conotrochus*) *strigata* Sowerby, 1894, is *Margarita musiva* Gould, 1861, *Limnaea parvia* von Martens, 1869 (= *Limnaea andersoniana* Nevill, 1871), is *Limnaea ollula* Gould, 1859, etc.

Moreover, the original collection from this expedition, after being studied by Gould, was believed to have been dispersed. A few of the specimens were incorporated in Gould's own collection which is now in the New York State Museum in Albany. Most of the remainder were in the care of its collector, William Stimpson. Therefore a part of the collection was preserved in the Smithsonian Institution in Washington where Stimpson was for years in charge of the Department of Invertebrate Zoology, and still a greater part was brought by him to the Chicago Academy of Sciences when he was elected as Secretary of the Academy and, later on, Director of the Museum. Subsequently a not inconsiderable part of this collection was destroyed in Chicago by the great fire in 1871. This has been confirmed by the early records of the Academy and, during my recent visit to that institution, I obtained the information that the loss included "the invertebrates of the United States North Pacific Exploring Expedition, largely collected in the Japanese Seas by Dr. Stimpson during the years 1853-1856. This collection included a large number of annelids, mollusks and radiates . . . ." It is very unfortunate that such a loss can never be replaced.

Having had the privilege of studying the Stimpson material still in existence at the U. S. National Museum and in the New York State Museum, I here present my notes and illustrations of the original specimens as an aid to future students. At the same time, it must be made clear, however, that it is difficult to ascertain in a number of cases whether or not the specimens represent the types of the respective species, since the measurements from such individuals do not agree even approximately with those given in the original descriptions. However, there seems to be little doubt that these specimens are a part of the original lot and are, probably, the only ones still in existence.

In expressing my thanks to those who rendered aid of various kinds towards the completion of this work, I am grateful to Dr. Edwin G. Conklin of the American Philosophical Society in Philadelphia for his keen interest and encouragement. A grant from the Johnson Fund of this Society was made to me for the purpose of carrying on my studies of Chinese mollusks in this country. To

Dr. C. C. Adams and Dr. Dayton Stoner of the New York State Museum, as well as to Dr. A. Wetmore and Dr. Paul Bartsch of the U. S. National Museum, I am thankful for their kindness and courtesy extended to me during my stay in their institutions for the purpose of examining the material discussed in the present work. They have also kindly furnished me with photographs of the type specimens with permission for their reproduction here.

## Systematic Account

### Family TROCHIDAE

#### **Euchelus verrucus** (Gould), 1861

Plate 50, figures 10, 11

*Diloma verruca* Gould, Proc. Boston Soc. Nat. Hist., **8**:18, March, 1861.

Type locality: "Coral Seas, China".

The original lot is in the U. S. National Museum, "Type C. 420, Smithsonian Institution 24190". It contains 2 specimens, the smaller one is reddish stained on the larger whorls, the other bears pinkish streaks on white. Their measurements are: 3.1 mm. in altitude, 2.8 mm. in width, with 4½ whorls; another 2.8 mm. in altitude, 2.4 mm. in width, with 4 whorls. The original was given as "axis, 4; diam. 3 millim".

#### **Monodonta glabratum** Gould, 1861

*Monodonta glabratum* Gould, Proc. Boston Soc. Nat. Hist., **8**:20, March, 1861.

Type locality: "China Seas".

The lot in the U. S. National Museum is marked with a query "? Type C. 2051", and contains a single specimen, measuring 20.0 mm. in altitude, 17.5 mm. in width, and with 6 whorls. It agrees well with *M. labio* Linné, but it does not seem to represent *M. glabratum* Gould. The original was given as "axis, 15; diam. 13 millim".

#### **Trochus lacertinus** (Gould), 1861

Plate 50, figures 1, 2

*Polydonta* (*Infundibulum*) *lacertinum* Gould, Proc. Boston Soc. Nat. Hist., **8**:19, March, 1861.

Type locality: "Hong Kong Harbor".

The lot in the U. S. National Museum is marked "Type C. 629, Smithsonian Institution 24888". It measures 19.0 mm. in altitude, 23.5 mm. in width and has 10 whorls. It is larger than any of the 4 specimens preserved in the New York State Museum (Gould Type Cat. No. 128, original no. 2420), but still is smaller than that given in the original description. Gould gave its measurements as "Diam. et axis, 25 millim".

### **Calliostoma acutum** (Gould), 1861

Plate 50, figures 6, 7

*Ziziphinus acutus* Gould, Proc. Boston Soc. Nat. Hist., **8**:19, March, 1861.

Type locality: "Eastern Coral Seas".

The lot in the U. S. National Museum is labelled "Type C. 414, Smithsonian Institution 24157", and measures 5.0 mm. in altitude, 4.0 mm. in width, and has 8 whorls; while in Gould's original description it is slightly smaller, given as "axis, 4; diam. 3 millim". The apical whorls are dark red, early ones pinkish and yellowish-green, and the later ones yellowish with white streaks. It seems to resemble closely *C. decussatum* (A. Adams, 1853) described from the Philippine Islands, which is of but slightly smaller size.

### **Minolia musiva** (Gould), 1861

Plate 50, figures 8, 9

*Margarita musiva* Gould, Proc. Boston Soc. Nat. Hist., **8**:15, March, 1861.

Type locality: "Hong Kong Harbor, in 10 fath., shelly gravel'.

The lot in the U. S. National Museum is labelled "Type C. 536, Smithsonian Institution 31126" and contains 2 specimens, one measuring 5.8 mm. in altitude, 5.2 mm. in width, with 6¼ whorls; another 4.6 mm. in altitude, 4.9 mm. in width, with 5¾ whorls.The lot in the New York State Museum is marked as "Gould Type Cat. No. 142 (original no. 2440)" which also contains 2 specimens of smaller size. Gould's original description reads "axis, 6; diam. 5 millim".

### **Ethalia capillata** Gould, 1861

Plate 50, figures 16, 17

*Ethalia capillata* Gould, Proc. Boston Soc. Nat. Hist., **8**:17, March, 1861.

Type locality: "Coast of China, 23° 30′ N., in 25 fathoms, sandy".

The lot in the U. S. National Museum is marked "Type C. 1801, Smithsonian Institution 24233" and contains 3 specimens, the measurements in millimeters are as follows: altitude 4.9, width 7.9, with 6 whorls; altitude 4.3, width 6.8, with 5½ whorls; and altitude 3.5, width 5.4, with 4¼ whorls.

The lot in the New York State Museum is marked "Gould Type Cat. No. 121 (original no. 2453)," and contains 2 specimens of smaller size. These specimens agree well with the original description. The callus located at the columellar parietal angle of the aperture is tongue-shaped, and partly covers the umbilicus. The umbilicus is completely open in the young. The original dimensions were given by Gould as "axis, 4+; diam. 8 millim".

## Family CYCLOSTREMATIDAE

### **Cyclostrema modestum** Gould, 1859

Plate 50, figures 22, 23

*Cyclostrema modestum* Gould, Proc. Boston Soc. Nat. Hist., **7**:142, October, 1859.

Type locality: "Hong Kong".

The lot in the U. S. National Museum is labelled "Type C. 448, Smithsonian Institution 24170", and contains a single specimen, 4.3 mm. in width and 3.0 mm. in altitude, while the measurements given in the original description by Gould are "diam. 4 millim.; axis 2 millim".

## Family TURBINIDAE

### **Liotia solidula** Gould, 1859

Plate 50, figures 24, 25

*Liotia solidula* Gould, Proc. Boston Soc. Nat. Hist., **7**:141, October, 1859.

Type locality: "Dredged in 25 fathoms off the coast of China".

The lot in the U. S. National Museum is labelled "? Type C. 1295, Smithsonian Institution 24224", and contains 2 specimens. The locality given by Stimpson on the label for this species is "Kagosima".

### **Liotia asteriscus** Gould, 1859

Plate 50, figures 30, 31

*Liotia asteriscus* Gould, Proc. Boston Soc. Nat. Hist., **7**:142, October, 1859.

Type locality: "Hong Kong".

The lot in the U. S. National Museum is labelled "Type C. 2050, Smithsonian Institution 24055", and contains a single specimen, while the lot in the New York State Museum, "Gould Type Cat. No. 120 (original no. 2425)", contains 2 specimens. All these specimens are somewhat larger than the one in the original description.

The shell is minute in size, solid and thick, openly and widely umbilicated. The umbilicus is defined by a ridge-line externally. The whorls rapidly increase in width, having the surface marked by growth and by spiral lines, and this sculpture is prominently developed on later whorls into spiral rows of tubercles. There are 3 such rows on the body whorl. The upper 2 rows produce a biangulated appearance; the third row is on the base. The aperture is oblique, circular in form, having its peristome continuous, thick and double margined. The interior of the umbilicus is sulcated. Measurements: altitude 1.1 mm., width 2.0 mm., diameter of umbilicus 0.3 mm., with 4¼ whorls.

### **Leptothyra lenticula** (Gould), 1861

Plate 50, figures 32, 33

*Collonia lenticula* Gould, Proc. Boston Soc. Nat. Hist., **8**:21, March, 1861.

Type locality: "China Coral Seas".

The lot in the U. S. National Museum is labelled "Type C. 400, Smithsonian Institution 24196", and contains a single specimen in worn condition, but having its fine spiral sculpture traceable. Its umbilicus is completely covered by thick callus. It measures 3.0 mm. in altitude, 4.0 mm. in width, and has 4 whorls, while the original is "diam. 4; axis, 2 millim".

## Family LITTORINIDAE

### **Plesiotrochus luteus** (Gould), 1861

Plate 50, figures 42, 43

*Tectarius luteus* Gould, Proc. Boston Soc. Nat. Hist., **8**:14, March, 1861.

Type locality: "China Seas".

The lot in the New York State Museum is labelled "Gould Type Cat. No. 87 (original no. 2526)", and contains 2 specimens, one of which measures 5.0 mm. in altitude, 3.1 mm. in width, 8¼ whorls; the other 4.1 mm. in altitude, 2.9 mm. in width, with 7 whorls. The original is given as "axis, 6+; diam. 4.0 millim".

The shell is whitish, somewhat in worn condition, but its fine spiral sculpture is easily traceable. The body whorl is prominently carinated at the periphery and descends in front. The aperture is somewhat ventricose and has a thin lip-margin. This species seems to be related to *P. souverbianus* Fischer, 1878, described from Lifu Island.

## Family RISSOIDAE

### **Alvania trochlearis** (Gould), 1861

Plate 50, figures 38, 39

*Rissoina trochlearis* Gould, Proc. Boston Soc. Nat. Hist., **7**:400, January, 1861.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type 661", and contains a single specimen. The internal side of the outer lip is sparsely dented with 2 to 3 well developed sulcations which are not mentioned in the original description. These sulcations correspond with the strong spirals externally.

### **Alvania ligata** Gould, 1861

Plate 50, figures 12, 13

*Alvania ligata* Gould, Proc. Boston Soc. Nat. Hist., **7**:402, February, 1861.

Type locality: "Dredged in Hong Kong Harbor".

The lot in the U. S. National Museum is labelled "Type 948", and contains a single specimen. The lot in the New York State Museum is labelled "Gould Type Cat. No. 93 (original no. 2467)", and contains a single specimen. It seems to be identical with the preceding species, but Gould considered them as belonging to different genera as well as species.

The shell is small and thick, having its peristome continuous, bluish porcellaneous inside of the aperture, having its outer lip somewhat expanded, thickened externally and dentate within. The sculpture consists of strong, spiral keels throughout the shell except on the apical part. Measurements: altitude 3.8 mm., diam. 2.0 mm., with 7 whorls.

### **Alvania fusca** Gould, 1861

Plate 50, figures 18, 19

*Alvania fusca* Gould, Proc. Boston Soc. Nat. Hist., **7**:403, February, 1861.

Type locality: "Dredged in Hong Kong Harbor".

The lot in the U. S. National Museum is marked "Type Smithsonian Institution 37347", and contains a single specimen. The lot in the New York State Museum is labelled "Gould Type Cat. No. 94 (original no. 2466)", and contains 2 specimens. The locality given on the label for the second lot is "Hakodadi". They nearly approach in size that given in the original description.

### **Rissoina nitidula** Gould, 1861

Plate 50, figures 26, 27

*Rissoina nitidula* Gould, Proc. Boston Soc. Nat. Hist., **7**:400, January, 1861.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type C. 578, Smithsonian Institution 24071", and contains a single specimen, measuring 5.0 mm. in altitude, 2.1 mm. in width, with 8½ whorls. The original measurements were given by Gould as "axis 5; diam. 2 millim".

### **Hyala abnormis** Gould, 1861

Plate 50, figures 34, 35

*Hyala abnormis* Gould, Proc. Boston Soc. Nat. Hist., **7**:408, February, 1861.

Type locality: "China Sea; coral regions".

The lot in the U. S. National Museum marked "Type 392", contains a single specimen. The species is distinguished by its minute size, glossy surface, bearing but very fine striae and by being almost translucent. The generic position is uncertain, Gould himself suggested that it might belong to *Auriculina* Gray except for the lack of a columellar fold. It may belong to *Cecina* A. Adams.

## Family THIARIDAE

### **Semisulcospira libertina** (Gould), 1859

Plate 50, figures 40, 41

*Melania libertina* Gould, Proc. Boston Soc. Nat. Hist., **7**:42, June, 1859.

Type locality: "Simoda and Ousima, in sluggish streams and ditches". Japan.

The lot in the U. S. National Museum is marked "Type C. 2120", and contains 3 specimens from Ousima. This is a common species occurring in eastern Asia. It has been repeatedly recorded from the lower Yangtze valley as well as the coast of the southern provinces. There is another lot of 2 specimens from Simoda also preserved in the U. S. National Museum. The figured specimen is from Ousima.

## Family POTAMIDIDAE

### **Batillaria placida** (Gould), 1861

Plate 50, figures 3, 4

*Cerithium placidum* Gould, Proc. Boston Soc. Nat. Hist., **7**:386, January, 1861.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type C. 443, Smithsonian Institution 24137", and contains a single specimen, measuring 6.5 mm. in altitude, 2.1 mm. in width, with 10 whorls. The original was given by Gould as "axis 8; diam. 2 millim". The specimen is in worn condition, but its sculpture is easily traceable; the spiral lines are more prominently developed. The apical part is injured.

### **Bittium glareosum** Gould, 1861

Plate 50, figure 5

*Bittium glareosum* Gould, Proc. Boston Soc. Nat. Hist., **7**:387, January, 1861.

Type locality: "Port Lloyd, Bonin Is., and Loo Choo Is."

The lot in the U. S. National Museum is marked "Type 2422", and contains 6 specimens, the largest one measures 6.0 mm. in altitude, 2.0 mm. in width, with 10 whorls. It has been recorded from Hong Kong as well as from the southern coast of China.

### **Bittium alutaceum** Gould, 1861

Plate 50, figures 14, 15

*Bittium alutaceum* Gould, Proc. Boston Soc. Nat. Hist., **7**:387, January, 1861.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type C. 531, Smithsonian Institution 24179", and contains a single specimen which measures 7.2 mm. in altitude, 3.1 mm. in width, and having 9 whorls.

### **Bittium craticulatum** Gould, 1861

Plate 50, figures 20, 21

*Bittium craticulatum* Gould, Proc. Boston Soc. Nat. Hist., **7**:387, January, 1861.

Type locality: "Hong Kong; laminarian zone".

The lot in the New York State Museum is labelled "Gould Type Cat. No. 57 (original no. 2471)," containing 7 specimens. Two of the larger specimens yield these measurements: one 7.0 mm. in altitude, 2.1 mm. in width, 10+ whorls; and another 6.0 mm. in altitude, 1.9 mm. in width, with 11½ whorls. The smaller specimen has its apical whorls well preserved.

## Family CERITHIOPSIDAE

### **Joculator semipictus** (Gould), 1861

Plate 50, figures 28, 29

*Cerithiopsis semipictus* Gould, Proc. Boston Soc. Nat. Hist., 7:388, January, 1861.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type C. 376, Smithsonian Institution 24208", and contains a single specimen in worn condition and somewhat injured on the early whorls, however, the coloration is well retained. It seems to resemble somewhat *J. ridiculus* (Watson, 1886), described from Australia.

### **Cerithiopsis laqueata** Gould, 1861

Plate 50, figure 44

*Cerithiopsis laqueata*, Gould, Proc. Boston Soc. Nat. Hist., 7:387, January, 1861.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "C. 505b, Smithsonian Institution 24098", and contains a single specimen, measuring 9.4+ mm. in altitude, 2.2 mm. in width, and having more than 13 whorls. The original measurements given by Gould were, "axis 8; diam. 2 millim".

## Family PYRAMIDELLIDAE

### **Actaeopyramis sinuata** (Gould), 1861

Plate 50, figures 36, 37

*Monoptygma sinuata* Gould, Proc. Boston Soc. Nat. Hist., 7:406, February, 1861.

Type locality: "China Seas".

The lot in the New York State Museum is marked "Gould Type Cat. No. 47 (original no. 2459)", and contains a single specimen, measuring 7.3 mm. in altitude, 3.3 mm. in width, with 6 whorls, but the original was given by Gould as "axis 18; diam. 4 millim". Could the measurement "axis 18" mm. given by Gould be a typographic error?

### **Actaeopyramis puncticulata** (Gould), 1861

Plate 50, figures 45, 46

*Monoptygma puncticulata* Gould, Proc. Boston Soc. Nat. Hist., **7**:405, February, 1861.

Type locality: "China Seas".

The lot in the New York State Museum is marked "Gould Type Cat. No. 45 (original no. 2457)", and contains a single specimen which is 10.0 mm. in altitude, 3.1 mm. in width, and with 8 whorls. The original was given by Gould as "axis 10; diam. 3.5 millim".

## Family FOSSARIDAE

### **Fossarus tornatilis** (Gould), 1859

Plate 51, figures 1, 2

*Fossar tornatilis* Gould, Proc. Boston Soc. Nat. Hist., **7**:44, June, 1859.

Type locality: "Hong Kong Harbor, 10 faths."

The lot in the U. S. National Museum is labelled "Type, 560", and contains a single specimen, measuring nearly the same size as that given in the original description.

## Family COLUMBELLIDAE

### **Pyrene araneosa** (Gould), 1860

Plate 51, figure 3

*Columbella araneosa* Gould, Proc. Boston Soc. Nat. Hist., **7**:336, September, 1860.

Type locality: "Kagosima Bay and China Coast".

The lot in the U. S. National Museum is labelled "Type C. 1368, Smithsonian Institution 24180", and contains a single specimen, measuring 9.5 mm. in altitude, 4.0 mm. in width, with 9 whorls.

It seems to be very closely related to *Pyrene martensi* (Lischke, 1871), which is a very common form found on the Chinese coast.

### **Pyrene bicincta** (Gould), 1860

Plate 51, figure 4

*Columbella bicincta* Gould, Proc. Boston Soc. Nat. Hist., **7**:335, September, 1860.

Type locality: "Hong Kong Harbor, 10 fathoms, shelly sand".

The lot in the U. S. National Museum is labelled "Type C. 517, Smithsonian Institution 24167", and contains a single specimen, 9.0 mm. in altitude, 4.0 mm. in width, with 7+ whorls. *Pyrene planaxiformis* (Sowerby, 1894), described from Hong Kong, is the same as this species, differing only by 0.5 mm. in width.

### **Pyrene lineolata** (Gould), 1860

Plate 51, figure 5

*Columbella lineolata* Gould, Proc. Boston Soc. Nat. Hist., **7**:335, September, 1860.

Type locality: "Hong Kong".

The lot in the U. S. National Museum is marked "Type C. 562, Smithsonian Institution 24199", and contains a single specimen, measuring 9.0 mm. in altitude, 3.6 mm. in width, with 8 whorls.

### **Anachis minuta** (Gould), 1860

Plate 51, figures 12, 13

*Columbella (Anachis) minuta* Gould, Proc. Boston Soc. Nat. Hist., **7**:334, September, 1860.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type C. 397, Smithsonian Institution 24231", and contains a single specimen, measuring 2.5 mm. in altitude, 1.2 mm. in width and having 5½ whorls.

### **Anachis atrata** (Gould), 1860

Plate 51, figures 14, 15

*Columbella (Anachis) atrata* Gould, Proc. Boston Soc. Nat. Hist., **7**:334, September, 1860.

Type locality: "Hong Kong Harbor".

The lot in the U. S. National Museum is marked "Type C. 2026, Smithsonian Institution 24172", and contains 3 specimens. The lot in the New York State Museum is marked "Gould Type Cat. No. 30 (original no. 2464)", and contains 2 specimens.

The shell is small in size, ovate-oblong or subfusiform in outline, solid and thick, of reddish-brown coloration. The whorls are scarcely convex and rapidly increase in height. The suture is superficial but well marked by a strong spiral line. The surface is sculptured by strongly developed riblets throughout, except in the last third of the body whorl where these riblets become obsolete. There are a few spiral sulcations towards the base. The aperture is narrowly oblong, open below, having its outer lip thickened externally, sharp at superior margin and denticulated within; inner lip moderately callused and well defined. Measurements: altitude 4.9 mm., width 2.0 mm. with 6 whorls.

### **Anachis alternata** (Gould), 1860

Plate 51, figures 28, 29

*Columbella alternata* Gould, Proc. Boston Soc. Nat. Hist., **7**:335, September, 1860.

Type locality: "Hong Kong".

The lot in the U. S. National Museum is marked as "Type C. 582, Smithsonian Institution 24222", and contains a single specimen, measuring 3.5 mm. in altitude, 1.6 mm. in width, with 5 whorls.

### **Anachis virginea** (Gould), 1860

Plate 51, figures 33, 34

*Columbella virginea* Gould, Proc. Boston Soc. Nat. Hist., **7**:335, September, 1860.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type C. 382, Smithsonian Institution 24139", and contains 2 specimens. *Anachis peasei* (von Martens, 1871), described from the Sandwich [Hawaiian] Islands, seems to be very closely related, if not identical, with this species.

### **Anachis nebulosa** (Gould), 1860

Plate 51, figures 45, 46

*Columbella (Anachis) nebulosa* Gould, Proc. Boston Soc. Nat. Hist., **7**:333, September, 1860.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type C. 412, Smithsonian Institution 13283", and contains a single specimen measuring 5.9 mm. in altitude, 2.4 mm. in width, with 8 whorls. It is ovately oblong in outline, sculpture consisting of strong riblets and incised spiral lines, outer lip not thickened within, columellar plait not well developed. The generic position is uncertain.

## Family OLIVIDAE

### **Olivella spreta** Gould, 1860

Plate 51, figures 47, 48

*Olivella spreta* Gould, Proc. Boston Soc. Nat. Hist., **7**:383, December, 1860.

Type locality: "Hong Kong Harbor, in 10 faths., shelly sand".

The lot in the U. S. National Museum is marked "Type C. 516, Smithsonian Institution 24169", and contains a single specimen, measuring 6.0 mm. in altitude, 3.0 mm. in width with 4 whorls. *Olivella fortunei* (A. Adams) seems to be only a larger form of this species.

## Family MITRIDAE

### **Pusia russa** (Gould), 1860

Plate 51, figures 58, 59

*Mitra russa* Gould, Proc. Boston Soc. Nat. Hist., **7**:333, September, 1860.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type C. 431, Smithsonian Institution 24164", and contains a single specimen, appearing to be a young form, and measuring 5.5 mm. in altitude, 3.1 mm. in width, with a little more than 5 whorls. It seems to be closely related to *Pusia pardalis* (Kuester), a form reported from Polynesia, Philippines, Red Sea, Mauritius, etc.

## Family MARGINELLIDAE

### **Persicula tantilla** Gould, 1860

Plate 51, figures 60, 61

*Persicula tantilla* Gould, Proc. Boston Soc. Nat. Hist., **7**:384, December, 1860.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type C. 445, Smithsonian Institution 24258", and contains a single specimen, measuring slightly smaller than that given by Gould.

### **Crithe atomaria** Gould, 1860

Plate 51, figures 62, 63

*Crithe atomaria* Gould, Proc. Boston Soc. Nat. Hist., **7**:384, December, 1860.

Type locality: "China Seas".

The lot in the U. S. National Museum is marked "Type C. 386, Smithsonian Institution 24181", and contains but one specimen.

## Family TURRIDAE

### **Asthenotoma vallata** (Gould), 1860

Plate 51, figures 6, 7

*Drillia vallata* Gould, Proc. Boston Soc. Nat. Hist., **7**:336, September, 1860.

Type locality: "Vicinity of Hong Kong, in 10 fathoms, shelly mud".

The lot in the U. S. National Museum is labelled "Type C. 528, Smithsonian Institution 24195", and contains a single specimen, measuring 9.8 mm. in altitude, 3.2 mm. in width, with 10 whorls.

### **Eucithara lota** (Gould), 1860

Plate 51, figures 16, 23

*Cythara lota* Gould, Proc. Boston Soc. Nat. Hist., **7**:339, October, 1860.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type C. 413", and contains a single specimen, measuring 4.8 mm. in altitude, 2.8 mm. in width, with 5 whorls.

### **Mangelia dorsuosa** (Gould), 1860

Plate 51, figures 21, 22

*Columbella* (*Anachis*) *dorsuosa* Gould, Proc. Boston Soc. Nat. Hist., **7**:333, September, 1860.

Type locality: "Hong Kong".

The lot in the U. S. National Museum is marked "Type C. 495, Smithsonian Institution 14191", and contains a single specimen, measuring 6.0 mm. in altitude, 2.2 mm. in width, with 8 whorls. It is slightly smaller than that given in Gould's original description as "axis 7; lat. 3 millim".

### **Pseudorhaphitoma tetragona** (Gould), 1860

Plate 51, figures 8, 9

*Mangelia tetragona* Gould, Proc. Boston Soc. Nat. Hist., **7**:382, December, 1860.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "? Type C. 375, Smithsonian Institution 24197", and contains a single specimen, measuring 5.5 mm. in altitude, 2.0 mm. in width, with 7 whorls. The specimen is in worn condition, having its sculpture faintly traceable. This species seems to be related to *Pseudorhaphitoma ixicula* Hedley, 1922 (= *P. hexagonalis* Brazier, *non* Reeve).

### **Veprecula pungens** (Gould), 1860

Plate 51, figures 17, 18

*Clavatula pungens* Gould, Proc. Boston Soc. Nat. Hist., **7**:339, October, 1860.

Type locality: "Hong Kong Harbor, in 10 faths., shelly sand".

The lot in the U. S. National Museum is marked "C. 515", but is not mentioned as the "Type". The single specimen measures 9.0 mm. in altitude, 3.0 mm. in width, with 8 whorls, which agrees well with that given by Gould as "axis 9; diam. 3 millim".

### **Daphnella aspersa** (Gould), 1860

Plate 51, figures 24, 25

*Clathurella aspersa* Gould, Proc. Boston Soc. Nat. Hist., **7**:338, October, 1860.

Type locality: "Off Hong Kong, in 15 fathoms, shelly sand".

The lot in the U. S. National Museum is labelled as "Type C. 532, Smithsonian Institution 24147", and contains a single specimen, measuring 13.5 mm. in altitude, 3.9 mm. in width with 8 whorls.

### **Pseudodaphnella intaminata** (Gould), 1860

Plate 51, figures 10, 11

*Mangelia intaminata* Gould, Proc. Boston Soc. Nat. Hist., **7**:339, October, 1860.

Type locality: "China Seas".

The lot in the U. S. Nat. Museum is labelled "Type C. 402, Smithsonian Institution 24214", and contains a single specimen, measuring 6.3 mm. in altitude, 2.3 mm. in width, with 7 whorls, while the original given by Gould is "axis 7; diam. 3 millim".

### **Hemidaphne gouldi** Yen, nom. nov.

Plate 51, figures 19, 20

*Mangelia pura* Gould, Proc. Boston Soc. Nat. Hist., **7**:339, October, 1860, (*non* Reeve, 1846).

Type locality: "Hong Kong Harbor".

The lot in the U. S. National Museum is marked "Type C. 436, Smithsonian Institution 24246", and contains a single specimen, measuring 7.0 mm. in altitude, 2.2 mm. in width, with 7 whorls.

There is another lot in the New York State Museum labelled "*Daphnella deluta* (Gould Type Cat. No. 4, original no. 2495)" which should belong to this species, as the specimen bears no trace of color pattern and the outer lip is not denticulated within, and thus does not agree with Gould's description for *D. deluta*. It is identical with the species here named *Hemidaphne gouldi*.

The name *Mangelia pura* was used by Reeve (Conch. Icon., Vol. 3, sp. 63, pl. VIII, fig. 63, June, 1846) for a species recorded from South Australia. I propose the new name for the Chinese species in honor of its original author, A. A. Gould.

### **Hemidaphne deluta** (Gould), 1860

Plate 51, figures 26, 27

*Daphnella deluta* Gould, Proc. Boston Soc. Nat. Hist., **7**:339, October, 1860.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type C. 316, Smithsonian Institution 24225", and contains a single specimen, measuring 7.6 mm. in altitude, 2.5 mm. in width, with 7 whorls, while the original given by Gould is "axis 20; diam. 5 millim".

## Family ACTAEONIDAE

### **Actaeon secale** Gould, 1859

Plate 51, figure 32

*Actaeon secale* Gould, Proc. Boston Soc. Nat. Hist., **7**:141, October, 1859.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type 557", and contains a single specimen, agreeing in size as well as in general shape and sculpture with that given in the original description.

## Family RINGICULIDAE

### **Ringicula arctata** Gould, 1860

Plate 51, figures 30, 31

*Ringicula arctata* Gould, Proc. Boston Soc. Nat. Hist., **7**:325, September, 1860.

Type locality: "Hong Kong Harbor."

The lot in the U. S. National Museum is marked "? Type 567", and contains 2 specimens. This has been figured by Lischke from a specimen obtained in Japan, and his figure agrees well with the type.

### **Ringicula doliaris** Gould, 1860

Plate 51, figures 35, 36

*Ringicula doliaris* Gould, Proc. Boston Soc. Nat. Hist., **7**:325, September, 1860.

Type locality: "Hakodadi Bay, 6 fathoms, sandy mud". Japan.

The lot in the U. S. National Museum is marked "Type 1692", and contains a single specimen. The figure given by Watson for this species in the "Report on the Scientific Results of the Voyage of H. M. S. Challenger....Zoology, Vol. 15, Pt. 42", seems to have a more thickly callused inner lip and a more thickened outer lip.

## Family ATYIDAE

### **Atys muscaria** Gould, 1859

Plate 51, figures 40, 41

*Atys muscaria* Gould, Proc. Boston Soc. Nat. Hist., **7**:138, October, 1859.

Type locality: "China Seas".

The lot in the U.S. National Museum is marked "? Type 334", and contains a single specimen. It is minute in size, thin and greenish in color, its sculpture consists of finely incised spiral lines and weaker growth striae. Its outer lip is somewhat injured, appearing to be thin-margined and its columella is short and twisted. Measurements: altitude 4.5 mm., width 2.6 mm.

## Family SCAPHANDRIDAE

### **Cylichna protracta** Gould, 1859

Plate 51, figure 37

*Cylichna protracta* Gould, Proc. Boston Soc. Nat. Hist., **7**:140, October, 1859.

Type locality: "Coast of China".

The lot in the U. S. National Museum is labelled "? Type 1864", and contains a single specimen having a slightly smaller size than that given by Gould. It is solid and thick, bearing spiral sculpture, and its columella is short and rather strongly plicate.

### **Cylichna operosa** Gould, 1859

Plate 51, figure 38

*Cylichna operosa* Gould, Proc. Boston Soc. Nat. Hist., **7**:140, October, 1859.

Type locality: "Hong Kong Harbor".

The lot in the U. S. National Museum is labelled "Type 537", and contains a single specimen. It approaches the shape of the preceding species, but has a wider and thinner shell.

### **Cylichna melampoides** Gould, 1859

Plate 51, figures 43, 44

*Cylichna melampoides* Gould, Proc. Boston Soc. Nat. Hist., **7**:140, October, 1859.

Type locality: "China Seas".

The lot in the U. S. National Museum is marked "Type Smithsonian Institution 419", and contains a single specimen, measuring 4.0 mm. in altitude, 2.5 mm. in width. It is in worn condition, but its incised spiral lines are traceable at the basal part of the shell.

### **Cylichna villica** Gould, 1859

Plate 51, figure 53

*Cylichna villica* Gould, Proc. Boston Soc. Nat. Hist., **7**:139, October, 1859.

Type locality: "China Seas".

The lot in the U. S. National Museum is labelled "Type 418", and contains a single specimen. Judging by it the expression "utroque subconica" does not seem to be quite exact. It is truncate and flat on top, obtusely angulated at the shoulder, and somewhat reduced at the base. The lateral outline is gently convex. Measurements: altitude 3.2 mm. width 1.8 mm.

## Family PHILINIDAE

### **Philine vitrea** Gould, 1859

Plate 51, figure 64

*Philine vitrea* Gould, Proc. Boston Soc. Nat. Hist., **7**:139, October, 1859.

Type locality: "Dredged at Hong Kong".

The lot in the U. S. National Museum is labelled "Type Smithsonian Institution 24077", and contains 2 specimens. This species seems to be closely related to *Philine orientalis* A. Adams, 1854, but the shell is much thinner and translucent.

## Family LYMNAEIDAE

### **Galba ollula** (Gould), 1859

Plate 51, figures 42, 50

*Limnaea ollula* Gould, Proc. Boston Soc. Nat. Hist., **7**:40, June, 1859.

Type locality. "Streams and marshes on Hong Kong Island".

The lot in the U. S. National Museum is marked "Type C. 831", and contains 2 specimens. One of them is a species of *Succinea*. *Galba parvia* (von Martens, 1869), described from North China, and *G. andersoniana* (Nevill, 1871), described from Yunnan province, seem to be the same as *G. ollula*. This is a very common form occurring throughout China, and Gould's name so far has been neglected, however, it has priority.

## Family PLANORBIDAE

### **Gyraulus spirillus** (Gould), 1859

Plate 51, figures 49, 52

*Planorbis spirillus* Gould, Proc. Boston Soc. Nat. Hist., **7**:40, June, 1859.

Type locality: "Ousima". Japan.

The lot in the U. S. National Museum is labelled "Type 1557, Smithsonian Institution 24217", and contains 3 specimens. It seems to be closely related to *G. compressus* (Hutton), which is a very common species in Eastern Asia as well as in India.

### **Polypylis lucida** (Gould), 1859

Plate 51, figures 54, 55

*Segmentina lucida* Gould, Proc. Boston Soc. Nat. Hist., **7**:41, June, 1859.

Type locality: "Loo Choo".

The lot in the U. S. National Museum is labelled "Type C. 834, Smithsonian Institution 24243", and contains a single specimen. It seems to be closely related to *Polypylis hemisphaerula* (Benson, 1842), which is a common form existing along the Yangtze valley. The present specimen seems to be a young stage, and has its outer lip somewhat injured.

## Family CORILLIDAE

### **Plectopylis pulvinaris** (Gould), 1859

Plate 51, figures 39, 51

*Corilla pulvinaris* Gould, Proc. Boston Soc. Nat. Hist., **6**:424, February, 1859.

Type locality: "Hong Kong, high up in the ravines; also near Canton."

The lot in the New York State Museum is labelled "Gould Type Cat. No. 286 (original no. 2479)", and contains a single specimen in an imperfect state of preservation.

The shell is planorboid in form, large and thin. The apical surface is deeply and widely concave. The whorls are closely coiled and bear strong growth lines decussating the weaker spiral striae. The latter are visible only at a few places on the surface and not at all on the base. The aperture is elongately oval in outline, the parietal callus is very thin, the peristome whitish, callus, and well reflected. It measures 7.0 mm. in altitude, 19.0 mm. in width, 8.8 mm. in diameter of umbilicus, with 6¼ whorls. The measurements are larger than those given by Gould. As the specimen is partly injured, internal armature which may have been present is unknown.

## Family ENDODONTIDAE

### **Discus pauper** (Gould), 1859

Plate 51, figures 56, 57

*Helix pauper* Gould, Proc. Boston Soc. Nat. Hist., **6**:423, February, 1859.

Type locality: "On dead wood in thickets, Petropaulski, Kamtschatka, also Hakodadi (Isl. Jesso)".

There are 2 lots in the New York State Museum. One is labelled "Gould Type Cat. No. 234 (original no. 2478)", and contains 3 specimens; while the other lot "Gould Type Cat. No. 263 (original no. 2478)", contains 5 specimens.

The shell in discoidal, thin, having a low spire and widely open umbilicus. The whorls are decidedly convex and bear strong, costulate growth lines. The body whorl obliquely descends in front, is very obtusely angulated at the periphery and roundly convex at the base. The aperture is oblique, subovate in form, having its peristome simple and parietal callus thin. The largest specimen measures 4.0 mm. in altitude, 7.0 mm. in width, 2.4 mm. in diameter of umbilicus, and with 4½ whorls. This is a common species occurring in North China.

Plate 50

Figs. 1, 2. *Trochus lacertinus* (Gould). Specimen from original lot in the U. S. National Museum "Type C. 629, Smithsonian Institution 24888". Hong Kong Harbor, China.

Figs. 3, 4. *Batillaria placida* (Gould). Specimen in the U. S. National Museum "Type C. 443, Smithsonian Institution 24137". China Seas.

Fig. 5. *Bittium glareosum* Gould. Specimen from original lot in the U. S. National Museum "Type 2422". Originally described from Port Lloyd, Bonin Islands, and Loo Choo Islands.

Figs. 6, 7. *Calliostoma acutum* (Gould). Specimen in the U. S. National Museum "Type C. 414, Smithsonian Institution 24157". Eastern Coral Seas.

Figs. 8, 9. *Minolia musiva* (Gould). Specimen from original lot in the U. S. National Museum "Type C. 536, Smithsonian Institution 31126". Hong Kong Harbor, China, in 10 fathoms, shelly gravel.

Figs. 10, 11. *Euchelus verrucus* (Gould). Specimen from original lot in the U. S. National Museum "Type C. 420, Smithsonian Institution 24190". Coral Seas, China.

Figs. 12, 13. *Alvania ligata* Gould. From original lot in the U. S. National Museum "Type 948". Dredged in Hong Kong Harbor, China.

Figs. 14, 15. *Bittium alutaceum* Gould. Specimen in the U. S. National Museum "Type C. 531, Smithsonian Institution 24179". China Seas.

Figs. 16, 17. *Ethalia capillata* Gould. Specimen from original lot in the U. S. National Museum, "Type C. 1801, Smithsonian Institution 24233". Coast of China. Lat. 23° 30′ N., in 25 fathoms, sandy.

Figs. 18, 19. *Alvania fusca* Gould. Specimen from original lot in the U. S. National Museum "Type Smithsonian Institution 37347". Dredged in Hong Kong Harbor, China.

Figs. 20, 21. *Bittium craticulatum* Gould. Specimen from original lot in the New York State Museum "Gould Type Cat. No. 57 (original no. 2471)". Hong Kong, China, in the laminarian zone.

Figs. 22, 23. *Cyclostrema modestum* Gould. Specimen in the U. S. National Museum "Type C. 448, Smithsonian Institution 24170". Hong Kong, China.

Figs. 24, 25. *Liotia solidula* Gould. Specimen from original lot in U. S. National Museum"? Type C. 1295, Smithsonian Institution 24224". The locality on the label given by Stimpson is "Kagosima", Japan. The original locality given by Gould was "Dredged in 25 fathoms off the coast of China".

Figs. 26, 27. *Rissoina nitidula* Gould. Specimen in the U. S. National Museum "Type C. 578, Smithsonian Institution 24071". China Seas.

Figs. 28, 29. *Joculator semipictus* (Gould). Specimen in the U. S. National Museum "Type C. 376, Smithsonian Institution 24208". China Seas.

Figs. 30, 31. *Liotia asteriscus* Gould. Specimen in the U. S. National Museum "Type C. 2050, Smithsonian Institution 24055". Hong Kong, China.

Figs. 32, 33. *Leptothyra lenticula* (Gould). Specimen from original lot in the U. S. National Museum "Type C. 400, Smithsonian Institution 24196". China Coral Seas.

(*Continued on next page*)

Plate 50—*Concluded*

Figs. 34, 35. ***Hyala abnormis*** Gould. Specimen in the U. S. National Museum "Type 392". China Sea; coral regions.

Figs. 36, 37. ***Actaeopyramis sinuata*** (Gould). Specimen in the New York State Museum "Gould Type Cat. No. 47 (original no. 2459)". China Seas.

Figs. 38, 39. ***Alvania trochlearis*** (Gould). Specimen in the U. S. National Museum "Type 661". China Seas.

Figs. 40, 41. ***Semisulcospira libertina*** (Gould). Specimen from original lot in the U. S. National Museum "Type C. 2120". Originally cited from "Simoda and Ousima, in sluggish streams and ditches". Japan.

Figs. 42, 43. ***Plesiotrochus luteus*** (Gould). Specimen from original lot in the New York State Museum "Gould Type Cat. No. 87 (original no. 2526)". China Seas.

Fig. 44. ***Cerithiopsis laqueata*** Gould. Specimen from original lot in the U. S. National Museum "C. 505b, Smithsonian Institution 24098". China Seas.

Figs. 45, 46. ***Actaeopyramis puncticulata*** (Gould). Specimen in the New York State Museum "Type Cat. No. 45 (original no. 2457)". China Seas.

Plate 51

Figs. 1, 2. ***Fossarus tornatilis*** (Gould). Specimen in the U. S. National Museum "Type, 560". Hong Kong Harbor, China, in 10 fathoms.

Fig. 3. ***Pyrene araneosa*** (Gould). Specimen in the U. S. National Museum "Type C. 1368, Smithsonian Institution 24180". Originally cited from "Kagosima Bay and China Coast".

Fig. 4. ***Pyrene bicincta*** (Gould). Specimen in the U. S. National Museum "Type C. 517, Smithsonian Institution 24167". Hong Kong Harbor, 10 fathoms, shelly sand.

Fig. 5. ***Pyrene lineolata*** (Gould). Specimen in the U. S. National Museum "Type C. 562, Smithsonian Institution 24199". Hong Kong, China.

Figs. 6, 7. ***Asthenotoma vallata*** (Gould). Specimen in U. S. National Museum "Type C. 528, Smithsonian Institution 24195". Originally cited from "Vicinity of Hong Kong, in 10 fathoms, shelly mud". China.

Figs. 8, 9. ***Pseudorhaphitoma tetragona*** (Gould). Specimen in the U. S. National Museum "? Type C. 375, Smithsonian Institution 24197". China Seas.

Figs. 10, 11. ***Pseudodaphnella intaminata*** (Gould). Specimen in the U. S. National Museum "Type C. 402, Smithsonian Institution 24214". China Seas.

Figs. 12, 13. ***Anachis minuta*** (Gould). Specimen in the U. S. National Museum "Type C. 397, Smithsonian Institution 24231". China Seas.

(*Continued on next page*)

Plate 51—*Continued*

Figs. 14, 15. *Anachis atrata* (Gould). Specimen from original lot in the U. S. National Museum "Type C. 2026, Smithsonian Institution 24172". Hong Kong Harbor, China.

Figs. 16, 23. *Eucithara lota* (Gould). Specimen in the U. S. National Museum "Type C. 413". China Seas.

Figs. 17, 18. *Veprecula pungens* (Gould). Specimen in the U. S. National Museum labelled "C. 515". Hong Kong Harbor, China, in 10 fathoms, shelly sand.

Figs. 19, 20. *Hemidaphne gouldi* Yen, nom. nov. Specimen in the U. S. National Museum "Type C. 436, Smithsonian Institution 24246". Hong Kong Harbor, China. New name for *Mangelia pura* Gould, not *Mangelia pura* Reeve.

Figs. 21, 22. *Mangelia dorsuosa* (Gould). Specimen from original lot in the U. S. National Museum "Type C. 495, Smithsonian Institution 14191". Hong Kong, China.

Figs. 24, 25. *Daphnella aspersa* (Gould). Specimen in the U. S. National Museum "Type C. 532, Smithsonian Institution 24147". Originally cited from off Hong Kong, China, in 15 fathoms, shelly sand.

Figs. 26, 27. *Hemidaphne deluta* (Gould). Specimen in the U. S. National Museum "Type C. 316, Smithsonian Institution 24225". China Seas.

Figs. 28, 29. *Anachis alternata* (Gould). Specimen in the U. S. National Museum "Type C. 582, Smithsonian Institution 24222". Hong Kong, China.

Figs. 30, 31. *Ringicula arctata* Gould. Specimen from original lot in the U. S. National Museum "? Type 567". Hong Kong, China.

Fig. 32. *Actaeon secale* Gould. Specimen in the U. S. National Museum "Type 557". China Seas.

Figs. 33, 34. *Anachis virginea* (Gould). Specimen from original lot in the U. S. National Museum "Type C. 382, Smithsonian Institution 24139". China Seas.

Figs. 35, 36. *Ringicula doliaris* Gould. Specimen in the U. S. National Museum "Type 1692". Hakodadi Bay, Japan, 6 fathoms, sandy mud.

Fig. 37. *Cylichna protracta* Gould. Specimen in the U. S. National Museum "? Type 1864". Coast of China.

Fig. 38. *Cylichna operosa* Gould. Specimen in the U. S. National Museum "Type 537". Hong Kong Harbor, China.

Figs. 39, 51. *Plectopylis pulvinaris* (Gould). Specimen in the New York State Museum "Gould Type Cat. No. 286 (original no. 2479)". Originally described from Hong Kong, high up in the ravines; also near Canton, China.

Figs. 40, 41. *Atys muscaria* Gould. Specimen in the U. S. National Museum "? Type 334". China Seas.

Figs. 42, 50. *Galba ollula* (Gould). Specimen in original lot in the U. S. National Museum "Type C. 831". Originally described from streams and marshes on Hong Kong Island, China.

(*Continued on next page*)

PLATE 51—*Concluded*

Figs. 43, 44. *Cylichna melampoides* Gould. Specimen in the U. S. National Museum "Type Smithsonian Institution 419". China Seas.

Figs. 45, 46. *Anachis nebulosa* (Gould). Specimen in the U. S. National Museum "Type C. 412, Smithsonian Institution 13283". China Seas.

Figs. 47, 48. *Olivella spreta* Gould. Specimen from original lot in the U. S. National Museum "Type C. 516, Smithsonian Institution 24169". Hong Kong Harbor, China, in 10 fathoms, shelly sand.

Figs. 49, 52. *Gyraulis spirillus* (Gould). Specimen from original lot in the U. S. National Museum "Type 1557, Smithsonian Institution 24217". Ousima, Japan.

Fig. 53. *Cylichna villica* Gould. Specimen in the U. S. National Museum "Type 418". China Seas.

Figs. 54, 55. *Polypylis lucida* (Gould). Specimen in the U. S. National Museum "Type C. 834, Smithsonian Institution 24243". Loo Choo.

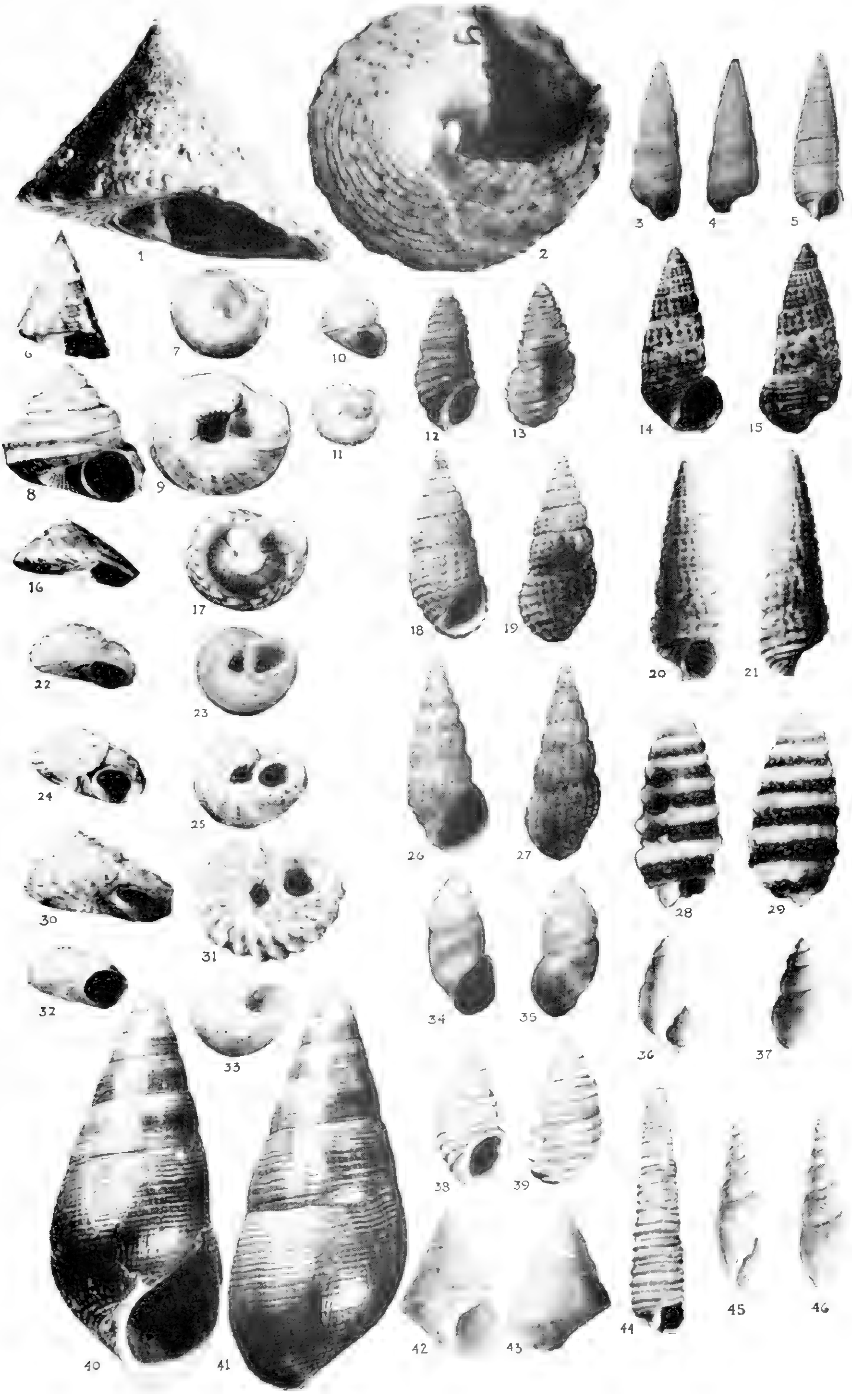
Figs. 56, 57. *Discus pauper* (Gould). Specimen from original lot in the New York State Museum "Gould Type Cat. No. 234 (original no. 2478)". Originally described as occurring on dead wood in thickets, Petropaulski, Kamtschatka, also Hakodadi (Island of Jesso).

Figs. 58, 59. *Pusia russa* (Gould). Specimen in the U. S. National Museum "Type C. 431, Smithsonian Institution 24164". China Seas.

Figs. 60, 61. *Persicula tantilla* Gould. Specimen in the U. S. National Museum "Type C. 445, Smithsonian Institution 24258". China Seas.

Figs. 62, 63. *Crithe atomaria* Gould. Specimen in the U. S. National Museum "Type C. 386, Smithsonian Institution 24181". China Seas.

Fig. 64. *Philine vitrea* Gould. Specimen in the U. S. National Museum "Type Smithsonian Institution 24077". Dredged at Hong Kong.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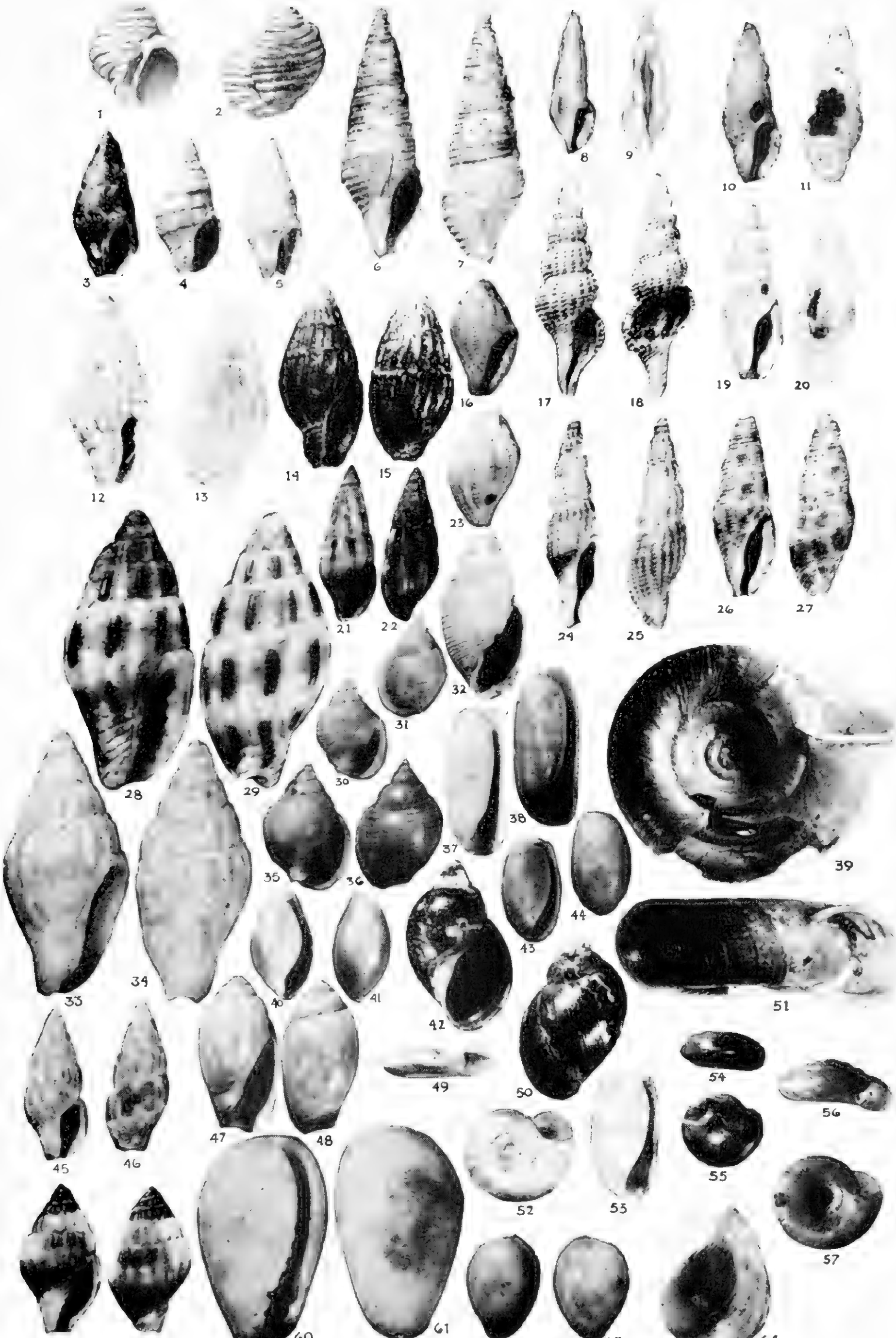

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No. 39

# RHINOBRYCON NEGRENSIS, A NEW GENUS AND SPECIES OF CHARACID FISHES FROM THE RIO NEGRO, BRAZIL

BY

GEORGE SPRAGUE MYERS

*Stanford University*

Among the fishes obtained by the late Dr. Carl Ternetz during his ascent of the Rio Negro in 1925, I have found a very interesting little tetragonopterid characin, allied to *Bryconamericus*, and its description is herewith presented.

## RHINOBRYCON Myers, new genus

Genotype.—*Rhinobrycon negrensis* Myers, new species.

This strange little characin forms one of the most distinctive genera of Tetragonopterinae, and one of the most easily recognized. Only three other genera of the subfamily have a projecting snout and inferior mouth, and two of these (*Creagrutus* and *Piabina*) have a peculiar, massive, three-rowed, premaxillary dentition, as well as a much heavier head. *Piabarchus* is more like a normal *Bryconamericus* in appearance, but is immediately distinguished from all its congeners by its very long anal fin, originating before the dorsal. None of the three is very similar to *Rhinobrycon* in appearance, but I believe that they as well as *Rhinobrycon* originated from *Bryconamericus* or from the same line from which *Bryconamericus* sprang.

Snout pointed in profile, projecting beyond the mouth, which is definitely inferior in position. Seen from below, the edge of the lower jaw is broadly arcuate, becoming somewhat restricted behind the point at which the maxillaries normally cover it, and the lower lip is sharp with its edge projecting horizontally, rather than vertically as in other characins. This lip fits up within the more vertically directed upper lip, which completely hides the premaxillary

August 22, 1944

teeth. The maxillary is shortened, being especially convex on its anterior margin, which meets the upper jaw at an angle very close to a right angle. The maxillary does not, however, have the strange form of that of *Creatochanes*. The mouth rather forcibly reminds one of those of certain *Scaphiodon*-like Asiatic cyprinids with an inferior mouth and sharp-edged, flaring, horny, lower lip, except that the lip of *Rhinobrycon* is not horny. The mouth, when closed, is almost exactly of the same general form and position as that of *Epalzeorhynchus*.

The pupil of the large eye is distinctly elongate vertically, although broad and not at all slit-like. In this character *Rhinobrycon* differs from nearly all the Tetragonopterinae.

Dentary with a single row of teeth, six or seven on each side, grading down gradually in size to the small posterior ones; the anterior teeth are 7- or 5-pointed, the middle cusp highest, and the cusps arranged in a very slight arc, convex side outward. Premaxillary teeth in two rows. The main, inner row is composed of an even row of four close-set teeth on each side; these are 7- or 5-cusped, the central cusp highest, and the cusps arranged in a much stronger arc, concave side forward. Outer row of premaxillary teeth formed of four or five small conical or faintly tricuspid teeth on each side, spaced widely, the row even or the third tooth set slightly back. Maxillary with two or three close-set, broadly tricuspid teeth at its upper end. All of the teeth are strong, and the larger ones have the sculptured surface common in *Bryconamericus* and other tetragonopterines, but the dentition in general appears to be more reduced and delicate than in most *Bryconamericus*.

Gill-rakers short, weak, setiform. Preventral area rounded, its squamation normal, with a regular median series of scales which are neither reduced nor enlarged. Predorsal line only weakly keeled posteriorly; anteriorly it is flat. Median predorsal scale row regular and complete, the scales equal in size to those on each side. A somewhat enlarged scale on each side of the base of the supraoccipital process. No procumbent predorsal spine. Scales regularly arranged, very little smaller on belly than elsewhere. Lateral line complete, weakly decurved, the lateral line series of scales parallel with the scale rows immediately above and below. Anal fin completely naked, lacking the usual shallow basal sheath of scales, the fin margin weakly concave. A lobe of large scales extending out for a short distance on the base of each lobe of the caudal fin, but these scales are deciduous and easily lost and I am not sure that they are invariably present in fresh specimens. In any case, they are not similar to the scaly covering of those genera said to have "caudal scales", and they do not extend out as far. Technically, this genus is to be placed with those genera which Eigenmann considered to have a naked caudal. Caudal lobes equal. On the body, the scales are not deeply imbricated, the hidden sector of the scale being shallow, the basal border squared with a slight, evenly curved convexity at its middle. Exposed sector evenly rounded, entire. The circuli are fine and radii, except at the limits of the visible sector, are absent. Adipose fin well developed. Males lack the squamous caudal pouch characteristic of the Glandulocaudinae.

Great suborbital in contact with the preopercular flange along its entire lower and posterior borders, leaving no naked spaces on the cheeks. A small lower and a larger, deeper, upper postorbital, both roughly rectangular in form and reaching the upper limb of the preopercular flange. The cheeks are thus fully armed.

Although the strange appearance of this little fish tends to obscure its relationships and emphasize its distinctiveness, I am certain that it is a close relative of *Bryconamericus*. It is, in fact, *Bryconamericus* with a produced snout; inferior, broadened lower jaw; sharp lower lip; shortened maxillary; weaker dentition; and conical or weakly tricuspid teeth in the front premaxillary row. It resembles such species as *B. eigenmanni*, *B. iheringii* and *B. ternetzi* in the compact, comparatively little-compressed body, short fins, and pale color, and is likely closely related to such species or derived from the same stem. However, the generic characters are very sharply defined, all known species of *Bryconamericus* having the lower jaw prominent and of the comparatively narrow, normal, tetragonopterine type.

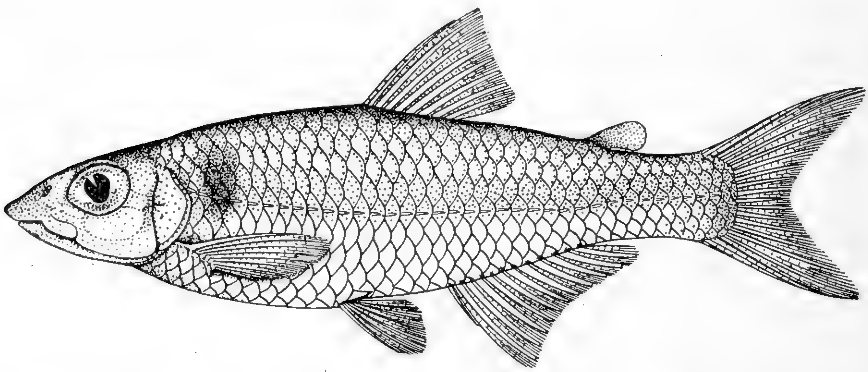
### **Rhinobrycon negrensis** Myers, new species

*Description.*—Head 3.6 to 4 times, depth 3.4 to 4 times in standard length. Dorsal 9 or 10. Anal 13 or 14. Caudal with 19 principal rays, the two outer unbranched. Pectoral 12. Scales 37 or 38 in lateral line, plus one or two on caudal base. Scales from dorsal origin to pelvic origin 4½-1-2½, the halves being small scales at the fin bases. Predorsal scales 11. Eye 2.4 to 2.7 in head, its length about a third longer than width of bony interorbital. Snout 2.8 to 3.4 in head.

Body trim and fusiform, its cross section oval and therefore less compressed than in most Tetragonopterinae. Occipital process triangular, shorter than a tenth the distance from its tip to dorsal fin, bordered on each side by only two scales. Top of cranium smooth, convex; length of the frontal section of the fontanel (to the frontal bridge) three fifths that of the parietal section without the supraoccipital groove. Maxillary-premaxillary angle sharp, the length of the maxillary from the angle to its end equals half length of eye. Dorsal origin midway between snout tip and middle of end of hypural fan, or slightly nearer latter, its height (anterior rays) slightly less than head length. Caudal lobes equal, each somewhat longer than head. Anal emarginate, the longest (anterior) rays considerably shorter than height of dorsal, its origin under the base of the eighth dorsal ray. Pelvics not reaching anus, which is just before anal origin. Pectorals falling short of reaching pelvics by a third the length of the former. Scales regularly imbricate, none especially elongate vertically; all closely adherent; supra-anal rows regular, not deflected; lateral line slightly decurved.

Pale yellowish, silvery. A faint, vertically elongate humeral spot at the third and fourth lateral-line scales. Scales of dorsum faintly dark edged. Fins clear except for a few melanophores on the basal half or third of each dorsal ray.

For comparison with related genera reference may be made to Eigenmann's *The Americam Characidae* (*Mem. Mus. Comp. Zool.*, vol. 43, 1917-1929).



*Rhinobrycon negrensis* Myers, new species. Holotype. Drawn by Pablo Bravo.

*Holotype.*—C. A. S. Ichthyology, No. 11089; 35 mm. standard length; **Santa Izabel, Rio Negro, Amazonas, Brazil;** Jan. 14, 1925; Dr. Carl Ternetz.

*Paratypes.*—C. A. S. Ichthyology, No. 11090; 20 specimens, 33 to 39 mm. standard length; same locality, date and collector.

Note: *Paratypes.*—Stanford 37076; 9 specimens; same locality, date and collector.

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No. 40

# TWO EXTRAORDINARY NEW BLIND NEMATOGNATH FISHES FROM THE RIO NEGRO, REPRESENTING A NEW SUBFAMILY OF PYGIDIIDAE, WITH A REARRANGEMENT OF THE GENERA OF THE FAMILY, AND ILLUSTRATIONS OF SOME PREVIOUSLY DESCRIBED GENERA AND SPECIES FROM VENEZUELA AND BRAZIL

BY

GEORGE SPRAGUE MYERS

*Stanford University*

Among the many interesting fishes obtained by the late Dr. Carl Ternetz in Brazil and Venezuela during 1923, 1924, and 1925, none is more remarkable than two singular species of minute blind pygidiids collected at the São Gabriel Rapids of the Rio Negro. A third genus with functional eyes but very nearly as peculiar was described by the writer in 1927, and these three are here placed together in a new subfamily, differing markedly from all other members of the family.

The collections were made by Dr. Ternetz under the direction of the late Dr. Carl Eigenmann for Indiana University. These as well as all of the other fish collections of that institution are now the property of the California Academy of Sciences.

November 7, 1944.

## GLANAPTERYGINAE Myers, new subfamily

Dorsal fin absent. Anal fin present or absent. Pectoral and pelvic fins reduced or absent. Nasal, rostral, and maxillary barbels present. No mental barbels. Cheeks without spines. Eyes very small and functional, or vestigial, or absent. Mouth small, with little or no lateral gape, not sucker-shaped. Teeth conical, apparently in a single series in each jaw. Three minute species, all of them known only from the vicinity of São Gabriel Rapids, Rio Negro, Brazil.

## **Pygidianops** Myers, new genus

Eyes apparently absent, no vestige of their presence visible externally. Body rather compact and laterally compressed; depth 6 in standard length. Snout flattened, shovel-shaped, merging at the sides into the connective membrane of the rostral and maxillary barbels. Nasal, rostral and maxillary barbels all with a stiff core and a fringing wing of membrane. A vestigial pectoral fin of one ray and fringing web, much like the barbels. No pelvic fins. Caudal fin well developed. Anal fin present. No dorsal fin, but a narrow rayless membrane down dorsum from nape to caudal. A similar membrane from behind anal fin to caudal.

Gill openings restricted to lower part of sides, below level of pectoral fin. Gill membranes forming a free fold across isthmus, attached to the latter at a single median line.

Mouth a transverse slit, narrow, inferior, far forward, slightly posterior to insertion of rostral barbel, without complicated lip structure or sucking disk. Teeth comparatively large, apparently conical and in a single close set series in each jaw. A constriction across lower surface of head, behind insertion of maxillary barbel. Myomeres very conspicuous.

*Genotype* the following species.

## **Pygidianops eigenmanni** Myers, new species

Plate 52, fig. 1; Pl. 53, figs. 3, 4, 5

Anal fin 5. Pectoral fin 1. Myomeres about 42 to caudal base. Caudal fin rounded. Depth 6 in standard length, body well compressed. Head 6.25. Distance from anal origin to caudal base contained 2.5 times in standard length. The barbels are stiffened by a cartilaginous core, and the nasal ones stand erect. A band of peculiar reticulate tissue from pectoral fin to above anal fin and another along base of dorsal fringe. A conspicuous papilla at anus.

There is a series of fine bones faintly visible in the opercular region, apparently branchiostegals. Two others, very similar, are seen above the pectorals. I have not dissected the types (only two or three of which are adult) in order to determine the relations of these bones, but a study of a stained and cleared example has been made by Miss Gloria Hollister, and it is hoped that her anatomical notes will be published.

White, without color.

*Holotype:* No. 11,120 C. A. S., Ichthyol., 23 mm. in standard length, from **rock pools below São Gabriel Rapids, Rio Negro, Brazil,** Feb. 1, 1925, Dr. Carl Ternetz.

Besides the type there are 13 other specimens ranging from 12 to 21 mm. standard length. Three of these 13 are in the collections of Stanford University.

It is especially appropriate that a blind fish, and particularly a blind fish from South America, be named in memory of the late Dr. Carl H. Eigenmann, to whom more than to any other we are indebted for our knowledge of both the blind fishes of the caves and the fish fauna of the fresh waters of South America.

## **Typhlobelus** Myers, new genus

Resembling *Pygidianops* in most characters, this genus differs as follows: Eyes vestigial, visible as minute black dots. Body greatly elongate, subterete in cross-section; depth 12 or 13 in standard length. Snout elongate, trowel-shaped, not merging into the membranous wings of the barbels. No vestige of a pectoral fin. Occiput bulbous behind. Caudal fin reduced. Teeth more widely spaced in jaws. Gill membranes as in *Pygidianops*. Mouth a little anterior to insertion of rostral barbels.

*Genotype* the following species.

## **Typhlobelus ternetzi** Myers, new species

Plate 52, fig. 2; Pl. 53, figs. 6, 7, 8

Anal fin 5. Myomeres 38 to origin of anal fin, number uncertain posteriorly, the total number probably about 50. Caudal fin rounded. Depth 12 to 13 in standard length. Body less compressed than in *Pygidianops*, subterete in cross-section. Head 8.8. Distance from anal origin to caudal base 3.3 in standard length. The barbels are stiff, but less so than in *Pygidianops;* their structure is similar. A rayless membrane along dorsum, and another from behind anal, to caudal. As in *Pygidianops* there is a band of reticulate tissue from pectoral region to above anal fin, set lower than in the other genus, and another at the base of the dorsal membrane for its entire length. A series of thin bones beneath the integument in the opercular region, perhaps branchiostegals.

White, colorless. A slight dark shade on top of head. Eye black.

*Holotype:* No. 11,118 C. A. S., 33.5 mm. in standard length, from **rock pools below São Gabriel Rapids, Rio Negro, Brazil,** Feb. 1, 1925, Dr. Carl Ternetz.

There are three paratypes, slightly smaller than the type, and from the same locality. One of them is in the collection of Stanford University.

It seems fitting that this peculiar little fish should bear the name of the late Dr. Carl Ternetz, whose valiant labors, while collecting these fishes in a little-known and fever-laden region, were the ultimate cause of his death.

### **Glanapteryx anguilla** Myers

Plate 54, figs. 9, 10, 11

Bull. Mus. Comp. Zoöl., 1927, LXVIII, p. 128.

This little fish, known from a single specimen collected at the same time and place as the above two, has very small but functional eyes. The anal as well as the dorsal is absent. What appear to be small pelvics are present, and the caudal, which is well formed in the other two genera, is reduced to a fringe. The fish differs greatly in appearance from the two blind genera, being dark brown in color and eel-like in form. The barbels are not stiff or fringed and the snout is blunt.

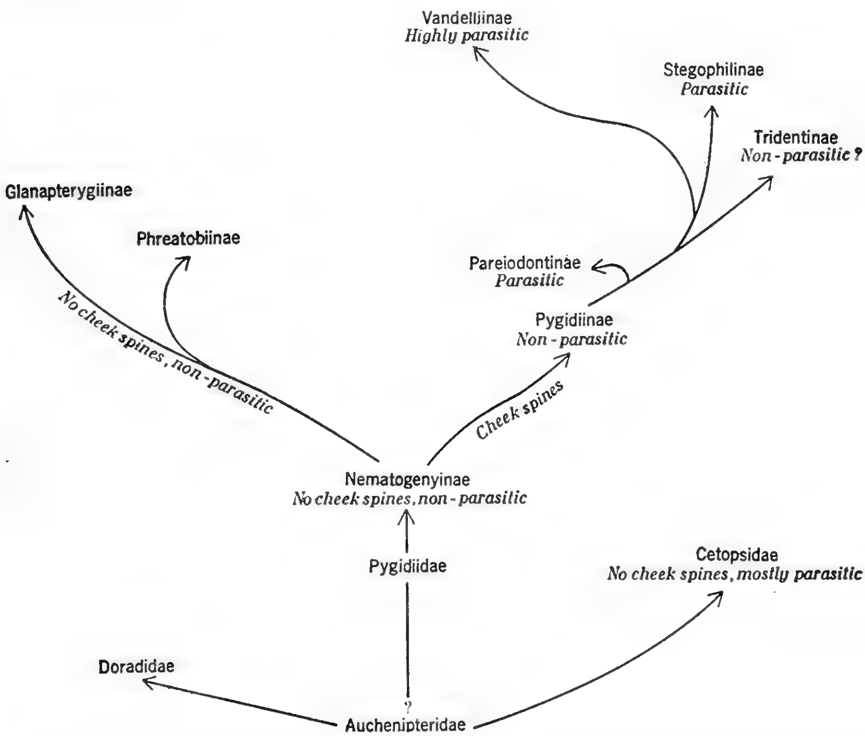
## DISCUSSION

The question of the habitat of the Glanapteryginae is unanswered. Dr. Ternetz is dead, and the data he gave ("rock pools below São Gabriel Rapids") are all that are known. The tiny mouth and weak, unspecialized dentition make me fairly sure that they are not parasitic. Very probably they spend their time buried in the sand, like *Pygidium*. The two blind genera were undoubtedly of a glassy translucency in life.

In spite of the considerable differences between *Glanapteryx* and the two blind genera, it would appear that they are not distantly related. The absence of the cheek spines and dorsal fin and the presence of nasal barbels show similarity and distinguish the group as a whole from most other pygidiids. Of course it may be argued that the absence of the dorsal, as well as the reduction of the paired fins, is merely a mark of independent degeneration, as the reduction of the eyes may well be, and, as such, of no significance as an indicator of phylogenetic relationship. While recognizing this possibility, I still feel that these fishes really are rather closely related. For one thing, the absence of cheek spines throws the three genera into a group with *Nematogenys*, the most primitive pygidiid, a group that, outside *Nematogenys* and the Glanapteryginae, includes only the strange, blind *Phreatobius cisternarum* of the Island of Marajó. I rather incline to believe that the absence of cheek spines is a primitive character which indicates the derivation of *Phreatobius* and the Glanapteryginae from some form similar to *Nematogenys*.

Moreover, the discovery of *Glanapteryx* and the blind genera does much to reduce the apparent gap between *Phreatobius* and *Nematogenys*, and to make it appear that the zoogeographically natural association of *Phreatobius* with the Pygidiidae is more reasonable than Fuhrmann's suggestion that the relations of *Phreatobius* are to be sought among the Afro-Asiatic Clariidae. It is true that the blind African clariid, *Uegitglanis*, described subsequent to Fuhrmann's work, resembles *Phreatobius* even more than the clariids known to him, but this resemblance is superficial.

While discussing the relationships of the blind genera, it seems useful to present a brief résumé of my tentative conception of the phylogenetic history of the pygidiid subfamilies. I do this in the form of a sketch (Text-fig. 1), upon which some comments are necessary. Little is known of the osteology of the family except for the Pygidiinae and *Plectrochilus* (= *Urinophilus*). But *Nematogenys*, as Eigenmann has said, seems to be the most primitive genus and I presume that it originated from the still more primitive Auchenipteridae (now reunited with the Doradidae by Gosline).




Text fig. 1. Sketch of suggested phylogeny of the subfamilies of Pygidiidae. The origin of the family from the Auchenipteridae is highly speculative, although the relationship of Cetopsidae to that family seems fairly certain. If the Tridentinae are not parasitic it is probable that their immediate ancestors were.

From the Auchenipteridae almost certainly arose the Cetopsidae, which Regan unites with the Pygidiidae, but which I prefer to regard as a distinct family, rather far removed from the pygidiid stem.[1]

From the Nematogenyinae, as indicated above, I believe the Glanapteryginae and Phreatobiinae to have developed, but they have travelled a long road. The Pygidiinae are practically identical with the Nematogenyinae except for the reduced maxillary and pectoral spine and the acquisition of interopercular and opercular spines. From the Pygidiinae, or perhaps from a parallel line, came the truly parasitic subfamilies, which all possess one or the other, or both patches of cheek spines. The Stegophilinae have specialized on a wide mouth and sucking disk, with which they attach themselves to other nematognaths, or to other aquatic animals, in order to use their fine teeth to rasp the skin to draw the blood upon which they feed. The Vandelliinae have developed an even more diabolical dentition, with which they attempt to penetrate the body wall of large nematognaths, and there suck blood, but they lack the large sucking disk of the Stegophilinae. To the Vandelliinae belong all the species of *candirú* that are accused of entering the human urethra (undoubted cases are on record of entrance into both male and female) and all those tiny forms that live in the gills of large fishes and suck blood from the gill filaments. The habits of the Tridentinae are unknown, but even if they are not parasitic, I believe that they originated from the stegophiline stem or perhaps even from some genus of that subfamily. *Haemomaster* is very suggestive of *Tridens*. The parasitic *Pareiodon* seems to be much closer to *Pygidium* than the others are; consequently I place it near the Pygidiinae. It has not the inferior mouth of the Vandelliinae, Stegophilinae, and Tridentinae.

## A Rearrangement of the Genera of Pygidiidae

The Pygidiidae were revised by Dr. Eigenmann in 1918 (Mem. Carnegie Mus., VII, pp. 259-398). More recently (1927, Mem. Nat. Acad. Sci., XXII, p. 37) he raised *Nematogenys* to family rank. Since several new genera have been described recently, and at least one of Eigenmann's main group characters shown to be inconstant, it seems best to regroup the generic categories.

With Dr. Eigenmann I would exclude the Cetopsidae, but *Nematogenys* is so evidently related to *Pygidium* that I think it better to retain it in the Pygidiidae. *Phreatobius* is included, for reasons given above.

[1]The development of bloodsucking habits in both the Cetopsidae and the more specialized and highly modified pygidiids is notable. As a matter of fact, it has been doubted that the cetopsids are parasitic; their large size would appear to make such habits scarcely credible. However, Mr. William G. Scherer, of Pevas, Loreto, Peru, has sent me a halfgrown *Cetopsis* that he caught when it attached itself to his leg and attempted to rasp the skin with its teeth and to suck blood. The Indians of the Amazon have long known that *Cetopsis* is a *candirú* or bloodsucker; this knowledge is preserved in the specific name of *Cetopsis candiru*.

## *Key to the Genera*

**1a.** No opercular or interopercular spine patches.

**2a.** Pectoral fin with a spine; mental and nasal barbels present; dorsal fin inserted over pelvics. (Subfamily Nematogenyinae) .......... ........................................... *Nematogenys* Girard 1854.

2b. Pectoral fin without spine or entirely absent.

3a. Dorsal fin absent; nasal, rostral and maxillary barbels present; no mental barbels; anal (if present) and caudal fins not confluent. (Subfamily Glanapteryginae).

4a. Anal fin present; eyes degenerate; caudal fin small but well developed.

5a. No externally visible vestige of eyes; snout shovel-shaped; pectoral fin present; form compact, compressed .............. ...................................... *Pygidianops* Myers 1944.

5b. A vestigial eye present; snout trowel-shaped; no pectoral fin; body very elongate, subterete .......... *Typhlobelus* Myers 1944.

4b. Anal fin absent; eyes functional; caudal degenerated into a fringe; eel-shaped .............................. *Glanapteryx* Myers 1927.

3b. Dorsal fin present; only maxillary and mental barbels present; anal and caudal fins confluent. (Subfamily Phreatobiinae) ......... ...................................... *Phreatobius* Goeldi 1904.

**1b.** A patch of spines on the interoperculum and usually on the operculum.

6a. Mouth subterminal, not sucker-like.

7a. Gill membranes free or narrowly connected with isthmus; caudal rounded to emarginate; head flattened; nasal barbel present. (Subfamily Pygidiinae).

8a. Opercle with long dermal flap; maxillary bone larger than its barbel ............................ *Scleronema* Eigenmann 1918.

8b. Opercle without dermal flap; maxillary very small.

9a. Dorsal fin long; caudal peduncle subterete . . *Hatcheria* Eigenmann 1909.

9b. Dorsal fin shorter; caudal peduncle compressed.

10a. Pelvic fins present ................... *Pygidium* Meyen 1835.

10b. Pelvic fins absent ................. *Eremophilus* Humboldt 1811.

7b. Gill membranes confluent with isthmus; caudal deeply forked; head rather deep; no nasal barbel. (Subfamily Pareiodontinae) .... ........................................... *Pareiodon* Kner 1855.

6b. Mouth inferior, sucker-like.

11a. Anal fin short, with 7 to 11 rays, its origin behind or rarely under the base of the dorsal fin.

12a. Rami of mandible meeting anteriorly; mouth wide; teeth many and fine, in bands or rows. (Subfamily Stegophilinae).

13a. Lips wide and extrusible, when extruded extending backward in points behind corners of mouth, normally folded into mouth; opercular spines absent . . . . *Apomatoceros* Eigenmann 1922.

13b. No backwardly extending extrusible lips; opercular spines present.

14a. Eyes lateral, wide apart, and staring; head very flat and depressed; interorbital nearly as wide as head and almost perfectly flat (as in *Tridens*) ........ *Haemomaster* Myers 1927.

14b. Eyes superior, close together, and usually partly hidden by the cheeks when viewed from the side; interorbital narrow, usually concave.

15*a*. Gill membranes united, free from the isthmus.......... ..............................*Acanthopoma* Lütken 1892.

15*b*. Gill membranes confluent with the isthmus.

16*a*. Caudal fin deeply forked, the lobes rather long and pointed; head and body rather deep and compact, the caudal peduncle slender; body with wide, dark, vertical bands..................................... ......*Pseudostegophilus* Eigenmann and Eigenmann 1889.

16*b*. Caudal fin emarginate, truncate, or rounded; body rather slender; head depressed; body spotted or plain.

17*a*. Accessory procurrent caudal rays numerous and conspicuous; tail tadpole-like, but not sharply pointed. ......................*Ochmacanthus* Eigenmann 1912.

17*b*. Accessory procurrent caudal rays few and relatively inconspicuous; caudal not tadpole-like.

18*a*. Operculum with only two spines................ ................*Henonemus* Eigenmann and Ward 1907.

18*b*. Operculum with four or more spines.

19*a*. Origin of pelvic fins almost equidistant from snout-tip and caudal origin....................... ............*Homodiaetus* Eigenmann and Ward 1907.

19*b*. Pelvic origin 1.5 to 2 times as far from snout-tip as from base of caudal fin................ .......................*Stegophilus* Reinhardt 1859.

12*b*. Rami of mandible separated anteriorly; mouth narrow; teeth large and few. (Subfamily Vandelliinae).

20*a*. Gill membranes united, free from isthmus; teeth present in lower jaw; rami of mandible rather close together.......... ...............................*Paracanthopoma* Giltay 1935.

20*b*. Gill membranes confluent with the isthmus.

21*a*. A large claw-like tooth at the end of each maxillary (scarcely visible without dissection); two series of depressible teeth in the middle of the upper jaw flanked laterally by a single series of much smaller teeth; two short series of teeth on ends of mandibular rami; caudal subtruncate.......... ............................*Branchioica* Eigenmann 1918.

21*b*. No claw-like tooth at end of maxillary (not verified in *Paravandellia*).

22*a*. A few depressible teeth in a single series in middle of upper jaw; caudal rounded or emarginate.

23*a*. Mandible devoid of teeth........................ ................*Vandellia* Cuvier and Valenciennes. 1846.

23*b*. A patch of minute teeth on each ramus of mandible.... .......................*Plectrochilus* Miranda-Ribeiro 1917.

22*b*. Several series of depressible teeth in middle of upper jaw flanked by a single series of smaller teeth at each side.

24*a*. A small series of teeth at extremities of the mandibular rami; caudal emarginate...................... .......*Parabranchioica* Devincenzi and Vaz-Ferreira 1939.

24*b*. Mandible devoid of teeth; caudal with upper lobe elongated.........*Paravandellia* Miranda-Ribeiro 1912.

11*b*. Anal fin long, with 15 to 25 rays, its origin in front of that of dorsal fin. (Subfamily Tridentinae).

25*a*. Opercular and interopercular patches of spines confluent with each other; gill membranes confluent with isthmus .................. *Miuroglanis* Eigenmann and Eigenmann 1889.

25*b*. Opercular and interopercular spine patches distinct from each other; gill membranes united, free from isthmus; eyes lateral, far apart; interorbital wide and flat.

26*a*. Body not greatly elongate, depth four to eight times in standard length; head 5.0 to 6.5 in standard length; interopercular spines four to eight in number.

27*a*. Opercular spines 10; two maxillary barbels present; nasal barbel present..................... *Tridentopsis* Myers 1925.

27*b*. Opercular spines 6; one maxillary barbel; nasal barbel absent .................................. *Tridensimilis* Schultz 1944.

26*b*. Body greatly elongate, depth of body 13 times in standard length; head about nine times in standard length; interopercular spines reduced to three or four................ ..................... *Tridens* Eigenmann and Eigenmann 1889.

*Incertae Sedis: Pleurophysus* Miranda-Ribeiro 1918. It is possible that this genus is the same as the more recently described *Paracanthopoma* of Giltay.

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In connection with the above review of the pygidiid genera it seems worthwhile to present illustrations of some unfigured genera and species of this family which I have described from among the collections of Dr. Ternetz in the museum of the Academy. These species are listed below.

### **Pygidium gabrieli** Myers

Plate 55, fig. 12

Copeia, 1926, no. 156, p. 151 (São Gabriel Rapids, Rio Negro, Brazil).

### **Haemomaster venezuelae** Myers

Plate 55. fig 13.

Bull. Mus. Comp. Zoöl., 1927, LXVIII, p. 131 (Playa Matepalma, Rio Orinoco, Venezuela).

### **Stegophilus septentrionalis** Myers

Plate 56, fig. 14

Bull. Mus. Comp. Zoöl., 1927, LXVIII, p. 130 (Santa Barbara, Rio Orinoco, Venezuela).

### **Ochmacanthus alternus** Myers

Plate 56, fig. 15

Bull. Mus. Comp. Zoöl., 1927, LXVIII, p.129 (Caño de Quiribana, near Caicara, Rio Orinoco, Venezuela).

### **Ochmacanthus orinoco** Myers

Plate 56, fig. 16

Bull. Mus. Comp. Zoöl., 1927, LXVIII, p. 130 (Playa Matepalma, Rio Orinoco, Venezuela).

## ADDENDUM

Except for the phylogenetic diagram and its accompanying discussion, the present paper stands very much as it was first written, almost fifteen years ago. The long delay in its presentation was due chiefly to a somewhat fitful search for an artist competent to draw detailed sketches of the heads of the new blind genera. The paper was finally submitted to the Academy for publication in May 1942, but wartime difficulties have delayed its printing. This delay enabled me to revise parts of the key, to include a new genus just described by Schultz, and to insert the phylogenetic diagram and a brief explanation of it. This was done while I was in Brazil, through the kind help of Miss Margaret Storey and Professor G. F. Ferris of Stanford.

Several notes on some of the genera recognized in the key are absolutely necessary, in the light of further information. Mr. Paulo de Miranda-Ribeiro of the Museu Nacional in Rio has shown me a small *Pygidium* from Minas Geraes that entirely lacks any external vestige of pelvic fins. He desired to refer his fish to *Eremophilus* but upon my advice decided not to do so. The pelvic fins of many fishes seem to be unstable genetically and specimens of many species of abdominal fishes are frequently found to lack the pelvics. Sometimes it would appear almost as if the presence or absence of ventral fins depended upon a unit character, genetically. It was long ago noted by Günther that burrowing fishes more frequently lack the pelvics than others. It may be added that elongate fishes do so more frequently than more robust species. *Pygidium* is both elongate and a burrower. I do not recall seeing a specimen of any species normally possessing truly thoracic pelvics that lacked these fins. At any rate, this anomalous *Pygidium* without pelvics brings up the validity of the generic separation of the sole species of *Eremophilus*, a genus separated from *Pygidium* only by the constant absence of these fins. The case bears some analogy to that of *Channa* and *Ophicephalus*. Myers and Shapovalov showed that *Channa* (lacking pelvics) was based upon a type species that turned out to be chimaerical; the type species consisted solely of anomalous (pelvicless) examples of a common *Ophicephalus*. Recent work in India has proved that we were correct. But *Channa* was an older name and replaced the better-known *Ophicephalus*. In the present instance *Eremophilus* is the older name and would replace the better-known *Pygidium* if the two genera were merged, but it must be noted that the basis for merging is much less than with the Asiatic forms. Moreover the genotype of *Eremophilus* is no chimera, but always lacks the pelvics, and we have but one small, anomalous fish upon which to base the name change, not only of a very large genus, but of a family as well. Since, in my opinion, taxonomy is a study of phylogeny and nomenclature is no real part of it, I see nothing wrong in retaining the name *Eremophilus* for a species that always lacks pelvics, and *Pygidium* as a genus that may, very rarely, produce an anomalous individual lacking them. Any other course leads to shifting over a hundred species to another genus, and of changing the well-known family name *Pygidiidae*. I may point out that, according to the rules followed by many zoologists and especially entomologists, the new name would not be Eremophilidae, but a name with an -idae ending based upon the oldest existing subfamily name (except, of course, Pygidiinae). Probably either Nematogenyidae or Stegophilidae would be the correct form.

Some of the other genera that I still continue to recognize in the key have comparatively little basis. *Homodiaetus* is very weakly differentiated from *Stegophilus* and probably should be sunk in synonymy, and I should not be surprised to see *Henonemus* follow the same fate when more material and more forms are known.

In the Tridentinae, I have recognized Schultz's *Tridensimilis*, though I have a strong feeling that this will ultimately prove to be inseparable from *Tridentopsis*. The only certain and well-marked character that separates them is the number of opercular spines (six versus ten). The characters of the maxillary and nasal barbels are already obscured by the two lesser known species, *Tridens brevis* and *Tridentopsis tocantinsi*, but I have left the barbel characters in the key (as characters of the genotypic species) on the faint chance that either *brevis* or *tocantinsi*, or each of them, may turn out to represent a different, well-marked genus.

*Vandellia* and *Plectrochilus* are two genera that I feel will eventually be merged. The presence versus the absence of a patch of minute teeth on each ramus of the mandible are not only characters subject to the condition of museum specimens and the care (or lack of it) of ichthyologists, but also characters that in some instances may approach each other so closely as to have little value. It should be remarked here that, in Rio de Janeiro, I have discovered the late Alipio de Miranda-Ribeiro to have described (in 1917) a genus that was unknown not only to Dr. Eigenmann, but also to the *Zoological Record.* This fish, *Plectrochilus machadoi*, turned out, upon examination of the poorly preserved type, to be identical with *Urinophilus diabolicus* Myers 1927. Also, the generic name *Plectrochilus* of 1917 must replace *Urinophilus* of 1920. *Urinophilus* was first proposed by Eigenmann in 1918 in a peculiar way. He had two groups of species, one with and one without mandibular teeth. He did not know to which group *Vandellia* belonged, so he put all the species tentatively in *Vandellia* and proposed *Urinophilus* (*in vacuo*, so to speak) for whichever group *Vandellia* did not turn out to represent. Two years later he settled the problem and *Urinophilus* must date from 1920.

*Plectrochilus machadoi* Miranda-Ribeiro, both genus (genotype by monotypy *P. machadoi*) and species, was described on page 50 of the following paper:

Miranda-Ribeiro, Alipio de. De Scleracanthis fluvio "Solimões" anno MCMVIII a cl. F. Machado da Silva duce brasiliense inventis et in Museo Urbis "Rio de Janeiro" servantis per classis dispositis vel descriptis. In: *Revista da Sociedade Brasileira de Sciencias*, Rio de Janeiro, No. 1, pp. 49-52. 1917.

G. S. Myers
Rio de Janeiro
May 4, 1944.

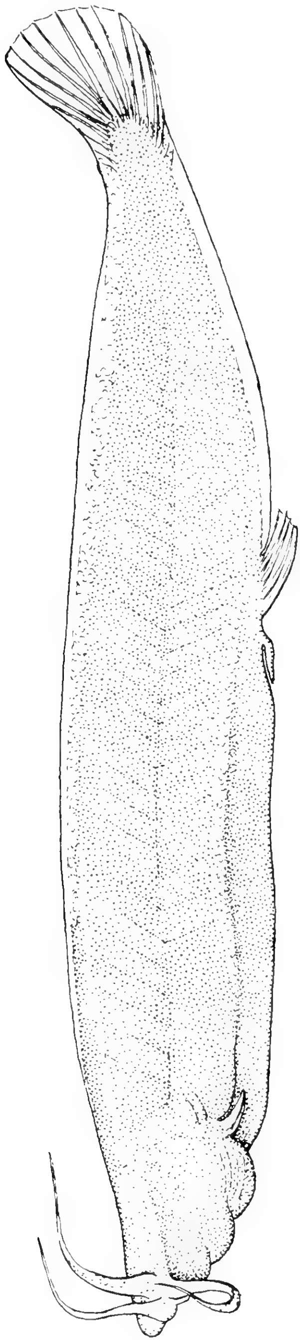
## EXPLANATION OF PLATES

### PLATE 52

(Drawn by G. F. FERRIS)

Fig. 1. *Pygidianops eigenmanni*, holotype. Side view.

Fig. 2. *Typhlobelus ternetzi*, holotype. Side view.



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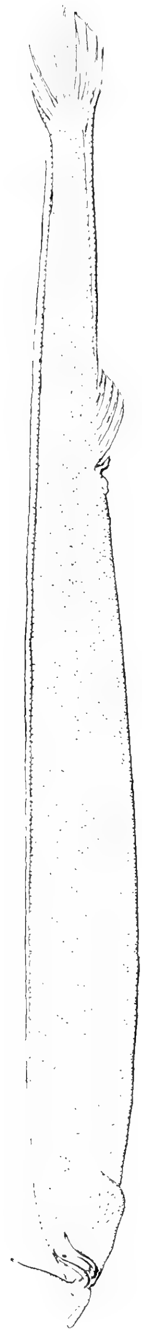

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PLATE 53

(Drawn by WALTER B. SCHWARZ)

Fig. 3. *Pygidianops eigenmanni*, holotype. Enlarged side view of head.

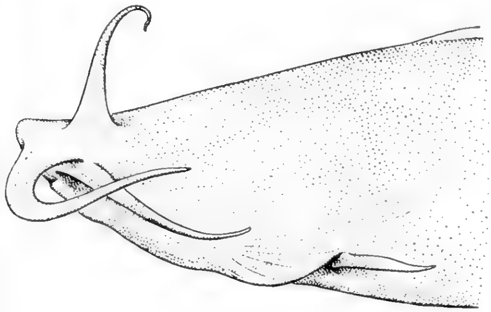
Fig. 4. *Pygidianops eigenmanni*, holotype. Enlarged dorsal view of head.

Fig. 5. *Pygidianops eigenmanni*, holotype. Enlarged ventral view of head.

Fig. 6. *Typhlobelus ternetzi*, holotype. Enlarged side view of head.

Fig. 7. *Typhlobelus ternetzi*, holotype. Enlarged dorsal view of head.

Fig. 8. *Typhlobelus ternetzi*, holotype. Enlarged ventral view of head.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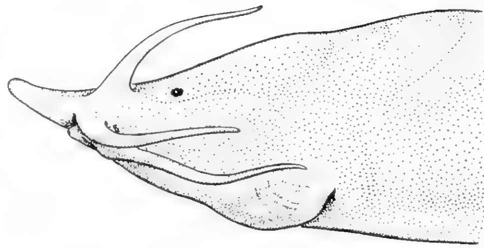
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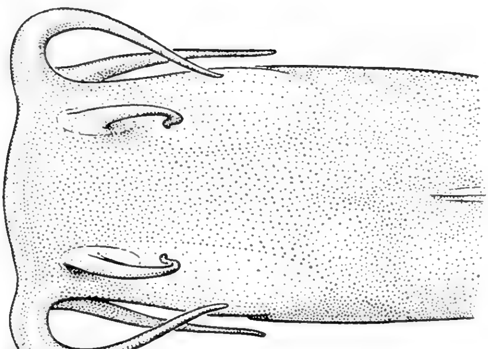
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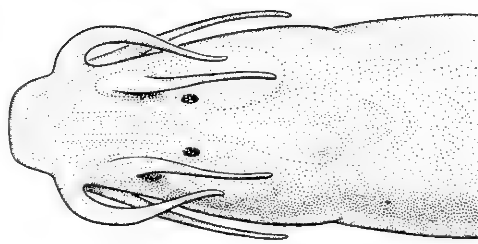
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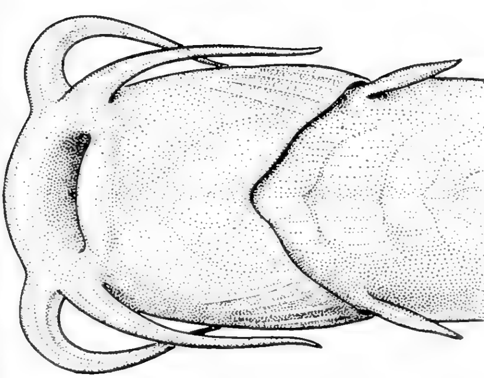
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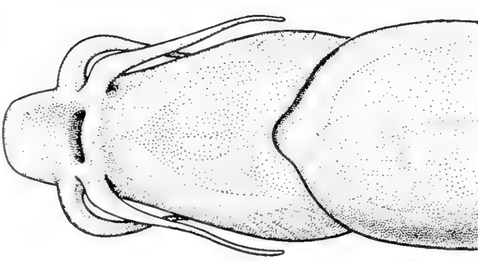
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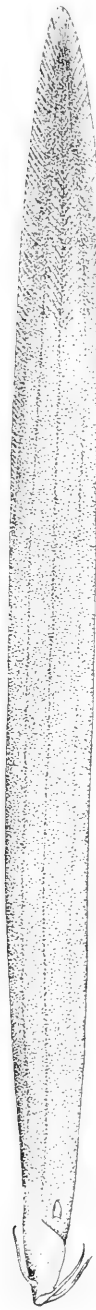
PLATE 54

Fig. 9. *Glanapteryx anguilla*, holotype. Side view. (Drawn by PABLO BRAVO).

Fig. 10. *Glanapteryx anguilla*, holotype. Enlarged dorsal view of head; the eyes are shown slightly too far apart. (Drawn by WALTER B. SCHWARZ.)

Fig. 11. *Glanapteryx anguilla*, holotype. Enlarged ventral view of head. (Drawn by WALTER B. SCHWARZ.)



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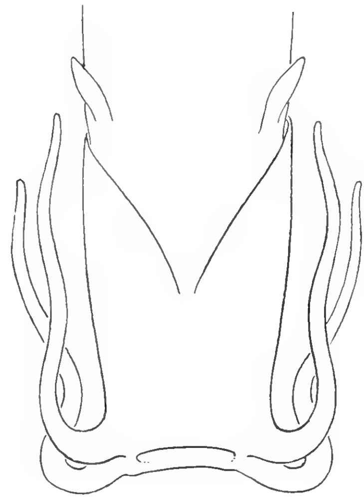

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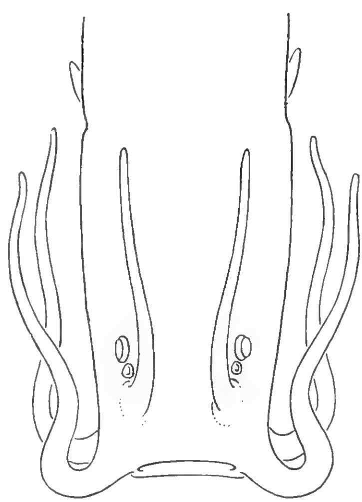

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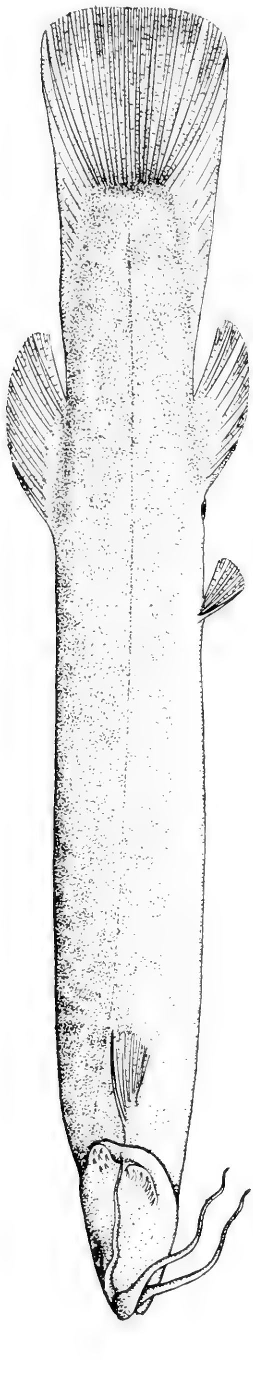
PLATE 55

(Drawn by PABLO BRAVO)

Fig. 12. *Pygidium gabrieli*, cotype (syntype). Side view.

Fig. 13. *Haemomaster venezuelae*, paratype. Side view, with inset showing dorsal view of head.



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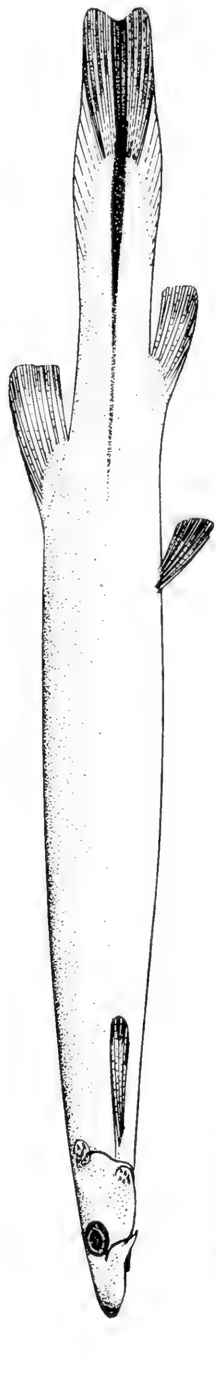

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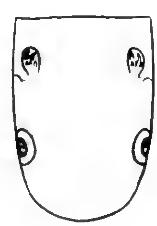


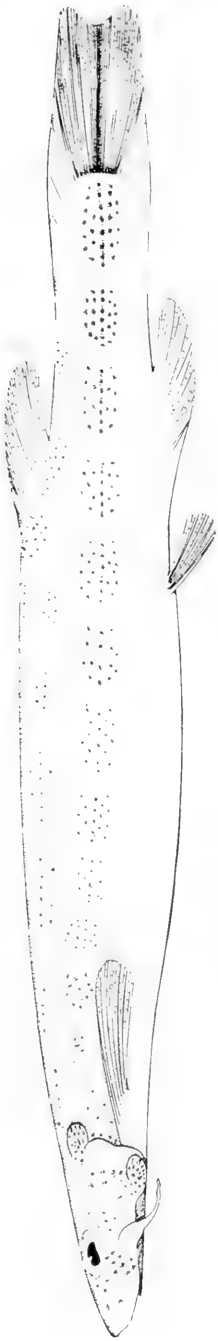
PLATE 56

(Drawn by PABLO BRAVO.)

Fig. 14. *Stegophilus septentrionalis*, holotype. Side view.

Fig. 15. *Ochmacanthus alternus*, cotype (syntype). Side view.

Fig. 16. *Ochmacanthus orinoco*, holotype. Side view.



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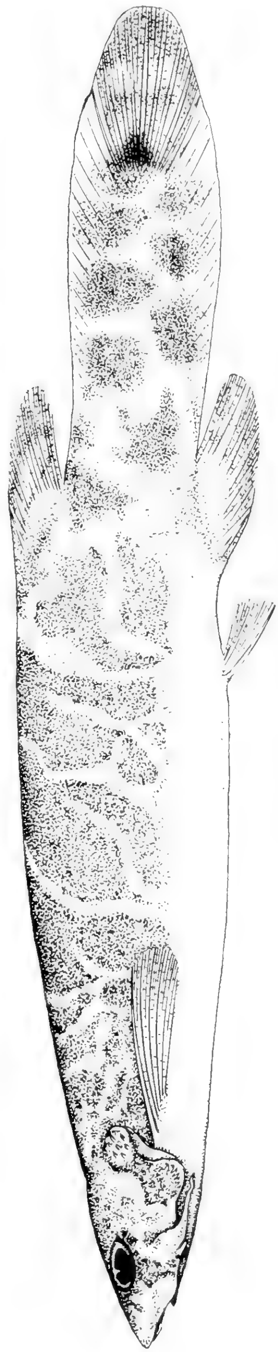

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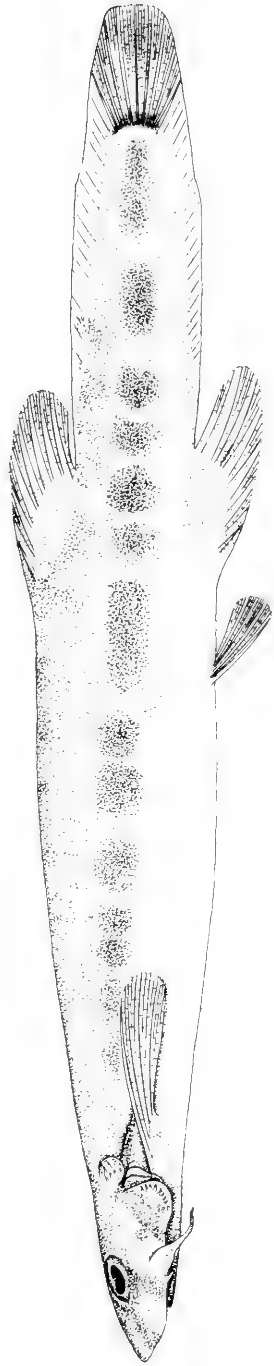

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**PROCEEDINGS**

OF THE

CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

VOL. XXIII, No. 41, pp. 603-609 SEPTEMBER 15, 1947

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**No. 41**

# THE ODONATE COLLECTIONS OF THE CALIFORNIA ACADEMY OF SCIENCES FROM BAJA CALIFORNIA AND TEPIC, MEXICO, OF 1889-1894

BY

PHILIP P. CALVERT
*Cheyney, Pennsylvania*

From 1889 to November, 1894, expeditions of the California Academy of Sciences made collections of Odonata in Baja California and in Tepic, Mexico, totalling more than 3100 specimens. These were listed and described by me in two papers published in the Proceedings of the California Academy of Sciences: "The Odonata of Baja California" (Proc. Calif. Acad. Sci. (2) 4:463-558, pls. xv-xvii, 1895) and "Odonata from Tepic, Mexico, with Supplementary Notes on those of Baja California" (Proc. Calif. Acad. Sci. (3) Zool. 1 (12):371-418, pl. xxv, May 22, 1899). By far the larger part of the material from Baja California on which the former paper was based was, according to letters in my possession, returned to the California Academy of Sciences in 1894, others later. Not all, however, for as I was working in 1899 on the Odonate part of the Biologia Centrali-Americana, I was given permission by the authorities of the Academy to retain for a time types and some other material to assist me in the preparation of the Biologia. This task was completed in 1908-09. In the meantime, the disastrous fire of 1906 destroyed, as I understand, all the Odonate material which I had returned to the Academy.

In view of the probability that students of the Odonata may have assumed that *all* of these collections were destroyed, I have prepared the present paper to indicate for each species listed in the two papers of 1895 and 1899 (a) the total number of specimens originally listed, (b) the specimens now in the California Academy's possession, and (c) the duplicate specimens allotted to me under Dr. Gustav Eisen's original proposal of January 25, 1893, when he suggested that I undertake the study of this material. The specimens of lot *c* have been placed in the collections of the Academy of Natural Sciences of Philadelphia, except that, where possible, some have been sent to the California Academy of Sciences to take the place of those destroyed in 1906 and are here included in lot *b*.

In the following lists, therefore, the first numbers for each species are *a* as above, the second *b*, the third *c*. The difference between *a* and $(b+c)$ represents the numbers lost in the conflagration of 1906. Immediately following the name of each species and its describer's name (or, if new, the abbreviation 'n. sp.') is a reference to the page number in my papers of 1895 and 1899 respectively.

In 1895 and 1899 it was not a universal custom to specify the type specimens of new species and none were designated in these two papers. In this present one I, therefore, fix lectotypes[1] for some of the species.

I. Odonata from Baja California (Proc. Calif. Acad. Sci. (2) 4 : 463-558, Feb., 1895).

1. *Hetærina californica* Hagen, p. 473. (*a*) 3♂, 2♀; (*b*) 0; (*c*) 0.

2. *Archilestes grandis* Rambur, p. 475. (a) 36♂, 26♀; (b) 4♂, 3♀; San José del Cabo, Oct., '93; (c) 2♂, 2♀, same locality and date.

3. *Argia agrioides* (Selys MS.) new species, p. 476. (a) 48♂, 26♀; (b) 2♂, 1♀, Baja Purissima, April, '89, 4♂, 2♀, San José del Cabo, May, '93; (c) 2♂, B. P. 2♂, 2♀, S. J. d. C., same dates respectively. None of the material of this species is listed in my paper of 1895 as from San José del Cabo in May, 1893; perhaps these so labeled now are of the lot listed there as "not dated"; I cannot account for the discrepancy in date. I fix one of the Baja Purissima males in the California Academy of Sciences, which bears my label "Original of pl. xv, fig. 14, Proc. Calif. Ac. Sci. (2) iv" as the lectotype (C. A. S. No. 5595) of *Argia agrioides*. The female from the same locality lacks abdominal segments 5-10 and I therefore fix one of the females from San José del Cabo, in the California Academy of Sciences as the lectallotype (C. A. S. No. 5596).

4. *Argia vivida* (Hagen) Selys, p. 478. (a) 9♂, 6♀; (b) 1♂ Baja Purissima, April, '89; (c) 2♂ same locality and date.

5. *Argia cupræa* Hagen, p. 479. [Redescribed as *Argia tezpi* Calvert, Biol. Centr.-Amer. Neur. 77, 1902.] (a) 13♂, 13♀; (b) 2♂, 1♀ San José del Cabo, Oct., '93, 1♂, 1♀ Miraflores, Sept., '94; (c) 1♂, 1♀ S. J. d. C., 1♂ Miraflores, same dates respectively. The type of *tezpi* (C. A. S. No. 5597) was specified in the Introduction to the same Biologia volume, p. xxix, as San José del Cabo, coll. Acad. Sci., and with a female lectallotype (C. A. S. No. 5598) is included in the second group of numbers above.

6. *Argia ænea* (Hagen) Selys, p. 481. (a) 7♂; (b) 1♂, 1♀ San José del Cabo, Oct., '93; (c) 1♂, 1♀ same locality and date, 1♀ Miraflores, Sept., '94.

7. *Erythragrion salvum* Hagen, p. 483. (a) 83♂, 27♀; (b) 5♂, 3♀

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[1] In the sense employed by Cresson, Ent. News 45:124, 1934.

San José del Cabo; (c) 5♂, 2♀ same. Four males from the original lot of "*salvum*" have been found to be *incolumis* Williamson[2]; two of them are in the California Academy of Sciences, two in the Academy of Natural Sciences of Philadelphia.

8. *Enallagma cæcum* Hagen, p. 485. (a) 20♂, 5♀; (b) 5♂ San José del Cabo, not dated; (c) 6♂, 1♀ same.

9. *Enallagma eiseni* n. sp., p. 486. (a) 17♂; (b) 1♂ Baja Purissima, April, '89, 1♂ Sierra San Lazaro, Sept., '94, 1♂ Mesa Vérde, Oct., '93; (c) 2♂ (heads lost) Baja Purissima, April, '89, 1♂ Sierra San Lazaro, Sept., '94. I here designate 1♂ Baja Purissima in the California Academy of Sciences (C. A. S. 5599) as the lectotype of this species.

10. *Ischnura ramburii* Selys, var. *credula* Hagen, p. 489. (a) 10♂, 17♀; (b) 2♂, 1♀ San José del Cabo, not dated, 3 orange ♀ id., Sept., '93; (c) 3♂, 1♀, 3 orange ♀ same locality, the last three Sept., '93[3].

11. *Ischnura exstriata* n. sp., p. 493. [=*I. denticollis* (Burm.)] (a) 4♂; (b) 0; (c) 0. All the Baja California examples presumably having been destroyed, I hereby designate as the lectotype of *I. exstriata* a male from "San Bernardino, Calif., Feb.-Mar., 1892, P. C. Truman, Fig. 2, pl. XV, Proc. Calif. Ac. Sci. (2) IV made from this ♂. P. P. Calvert" now in the collection of the Academy of Natural Sciences of Philadelphia.

12. *Ischnura cervula* Selys, p. 497. (a) 3♂, 1♀; (b) 0; (c) 0.

13. *Progomphus obscurus* Rambur, p. 499. (a) 7♂, 6♀; (b) 1♂, 1♀ San José del Cabo, (♂ Sept., ♀ Oct.); (c) Sierra El Taste, Sept., '93, 1♀ San José del Cabo, Oct., '93.

14. *Octogomphus specularis* (Hagen) Selys, p. 502. (a) 1♀; (b) 0; (c) O.

15. *Aeschna luteipennis* Burmeister, p. 503. (a) 3♂; (b) 0; (c) 1♂ Mesa Verde, Oct., '93, paratype of *Ae. l. peninsularis* Calvert, Ann. Ent. Soc. Amer. 34 (2) : 395, 1941.

16. *Aeschna cornigera* Brauer, p. 507. (a) 3♂, 1♀; (b) 0; (c) 1♂ San Raymundo, April, '89.

17. *Aeschna multicolor* Hagen, p. 505. (a) 21♂, 3♀; (b) 3♂ San José del Cabo, Oct., '93; (c) 3♂, 1♀ same locality and date.

18. *Aeschna constricta* Say, p. 509. [=*Ae. palmata* Hagen var?] (a) 17♂; (b) 2♂ La Chuparosa, Oct., '93; (c) 3♂ same locality and date.

19. *Anax junius* Drury, p. 509. (a) 82♂, 37♀; (b) 4♂ San José del Cabo, Oct., '93; (c) 5♂, 1♀ same locality and date.

20. *Anax walsinghami* McLachlan, p. 510. (a) 31♂, 7♀; (b) 4♂, 1♀ San José del Cabo, Oct., '93; (c) 3♂, 1♀ same locality and date, 1♂ Coral de Piedras, Sept., '93.

21. *Pantala flavescens* Fabricius, p. 512. (a) 17♂, 2♀; (b) 0; (c) 1♂ José del Cabo, Oct., '93.

22. *Pantala hymenæa* Say, p. 512. (a) 15♂, 15♀; (b) 1♂, 1♀ San José del Cabo, Oct., '93; (c) 3♂, 1♀ same locality and date.

23. *Tramea onusta* Hagen, p. 513. (a) 25♂, 3♀; (b) 1♂ Miraflores,

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[2] Occas. Papers Mus. Zool. Univ. Mich. 216:1, 1930.

[3] The paper on Odonata of Baja California contains the description of a new species, *Ischnura? erratica*, from California and Washington, page 491. I take this opportunity to designate as its lectotype and allotype respectively the male and female from Mendocino County, California (Amer. Ent. Soc. coll.), now in the Academy of Natural Sciences of Philadelphia; the male is Type No. 9223 and bears a label "fig. 1, pl. XV, Proc. Cal. Ac. Sci. (2) IV, drawn from this ♂ P. P. Calvert."

Sept., '94, 1♂ San José del Cabo, Oct., '93; (c) 3♂ S. J. d. C., Oct., '93.

24. *Tramea longicauda* Brauer? var., p. 514. (a) 2♂; (b) 0; (c) 1♂ San, José del Cabo, Oct., '93.

25. *Libellula saturata* Uhler, p. 516. (a) 79♂, 5♀; (b) 7♂, 1♀ San José del Cabo, Oct., '93 (one of these males is *croceipennis* Selys, another is intermediate between *saturata* and *croceipennis*; (c) 8♂, 2♀ same locality and date (one of these males is *croceipennis* Selys, another is intermediate between *saturata* and *croceipennis*. See Biol. Centr. Amer. Neur., pp. 211, 212, 1905.).

26. *Pseudoleon superbus* Hagen, p. 518. (a) 54♂, 18♀; (b) 1♂ Comondu, Mar., '93, 3♂, 2♀ San José del Cabo, Oct., '93; (c) 3♂, 2♀ S. J. d. C. (1♂ Sept., the other three Oct., '93).

27. *Orthemis ferruginea* Fabricius, p. 520. (a) 438♂, 237♀; (b) 8♂, 1♀ San José del Cabo (1♂, 1♀ Oct., '93, the other 7♂ not dated); (c) 9♂, 1♀ same locality (1♂, 1♀ Oct., '93, the other 8♂ not dated).

28. *Dythemis sterilis* Hagen, p. 522. 323♂, 253♀ (+ 17♂ on page 525); 4♂, 2♀ Sept., '94, 1♂, 1♀ Oct., '93, 1♂, 1♀ not dated (+ 2 Oct., '93); 6♂ Sept., '93, 1♂, 1♀ Oct., '93, 1♂, 2♀ not dated (+ 3♂ Oct., '93), all San José del Cabo. The numbers enclosed in parentheses are of the lot of 17♂ described on p. 525 and are paratypes of var. *nigrescens;* see under No. 26 of the Tepic paper cited below.

29. *Dythemis russata* (Hagen MS.) n. sp., p. 526 [= *Paltothemis lineatipes* Karsch]. (a) 12♂, 3♀; (b) 1♂, 1♀ Sierra Laguna, Oct., '93, 1♂ Sierra San Lazaro, Sept., '94; (c) 2♂, one from each of the same localities and dates. I hereby designate the Sierra Laguna male and female in the California Academy of Sciences as the lectotype (C. A. S. No. 5600) and lectallotype (C. A. S. No. 5601) respectively of *russata.*

30. *Dythemis mendax* Hagen, p. 529. (a) 2♂, 2♀; (b) 0;, (c) 1♂, 1♀ San José del Cabo, Sept. and Oct., '93, respectively.

31. *Macrothemis imitans* Karsch, p. 531. [= *M. pseudimitans* Calvert, Proc. Bost. Soc. Nat. Hist. 28 (12) : 329, 1898, and see under No. 29 of the Tepic paper, posteá.] (a) 8♂, 3♀; (b) 1♂, 1♀ San José del Cabo, Oct., '93; (c) 2♂ same locality and date. I hereby designate the male and female in the California Academy of Sciences as the lectotype (C. A. S. No. 5602) and lectallotype (C. A. S. No. 5603) respectively of *M. pseudimitans.*

32. *Macrothemis inequiunguis* n. sp., p. 533. (a) 20♂, 8♀; (b) 1♂, 1♀ San José del Cabo, Sept., '93, 1♂ Miraflores, Sept., '94; (c) 3♂, 1♀ San José del Cabo, Sept., '93 (♀ not dated), 1♂ Miraflores, Sept., '94. I hereby designate the male and female from San José del Cabo, Sept., '93, in the California Academy of Sciences as the lectotype (C. A. S. No. 5604) and lectallotype (C. A. S. No. 5605) respectively of this species.

33. *Trithemis basifusca* n. sp., p. 536. (a) 101♂, 38♀; (b) 3♂, 2♀ San José del Cabo, Oct., '93; (c) 6♂, 3♀ same. I hereby designate a male and a female in the California Academy of Sciences as the lectotype (C. A. S. No. 5606) and lectallotype (C. A. S. No. 5607) respectively of this species.

34. *Micrathyria didyma* Selys, p. 539. (a) 4♂; (b) 0; (c) 0.

35. *Micrathyria hagenii* Kirby, p. 540. (a) 144♂, 26♀; (b) 8♂, 2♀ San José del Cabo, Oct., '93; (c) 9♂, 2♀ same.

36. *Micrathyria æqualis* Hagen, p. 543. (a) 12♂, 2♀; (b) 2♂ San José del Cabo, Sept., '93, 1♂ Miraflores, Sept., '94; (c) 2♂, 1♀ San José del Cabo, Sept., '93.

37. *Diplax corrupta* Hagen, p. 545. (a) 33♂, 21♀; (b) 4♂ San José del Cabo, Oct., '93; (c) 4♂, 1♀ same locality and date.

38. *Diplax illota* Hagen, p. 545. (a) 13♂, 1♀; (b) 2♂ Mesa Verde, Oct., '93; (c) 3♂ same locality and date.

39. *Cannacria furcata* Hagen, p. 548. (a) 6♂, 1♀; (b) 0; (c) 1♂ San José del Cabo, Oct., '93.

40. *Mesothemis simplicicollis* Say, var. *collocata* Hagen, p. 552. (a) 60♂, 10♀; (b) 2♂ Miraflores, Sept., '94, 1♀, 2♀ San José del Cabo, Oct., '93; (c) 2♂ and 2♂, 1♀ from the same respective localities and dates.

Not numbered, not listed: *Pachydiplax longipennis* Burmeister. 1♀ San José del Cabo, Oct., '93, in the California Academy, recorded in Biol. Centr.-Amer. Neur. 341, 1907.

II. Odonata from Tepic, Mexico (Proc. Calif. Acad. Sci. (3) Zool. 1 (12): 371-418, May 22, 1899).

Except where otherwise stated, the following specimens are from Tepic.

1. *Hetærina americana* Fabricius, p. 372. (a) 45♂, 32♀; (b) 5♂, 6♀ Oct., '94; (c) 7♂, 7♀ same date.

2. *Archilestes grandis* Rambur, p. 374. (a) 3♂, 2♀; (b) 0; (c) 0.

3. *Lestes tenuatus* Rambur, p. 376. (a) 6♂, 14♀; (b) 2♀ Oct., '94; (c) 1♂, 2♀ same date.

4. *Mecistogaster ornatus* Rambur, p. 377. (a) 2♂; (b) 1♂ Barranca Blanca, Tepic, Nov., '94; (c) 1♂ same locality and date.

5. *Argia harknessi* sp. nov., p. 378. (a) 5♂, 1♀; (b) 1♂, 1♀ Oct., '94, 2♂ Nov., '94; (c) 2♂ Nov., '94. The type of this species was given as from Tepic in Biol. Centr.-Amer. Neur., explanation of pl. IV, fig. 45; to make the designation more precise, I hereby designate the male and female from Tepic, Oct., '94, in the California Academy of Sciences as lectotype (C. A. S. No. 5608) and lectallotype (C. A. S. No. 5609) respectively of this species.

6. *Argia extranea* Hagen, p. 380. (a) 2♂; (b) 1♂ Oct., '94; (c) 1♂ same date.

7. *Argia fissa* Selys, p. 381. (a) 2♂; (b) 1♂ Oct., '94; (c) 1♂ same date.

8. *Argia pulla* Selys, p. 383. (a) 43♂, 25♀; (b) 7♂ Oct., '94; (c) 7♂ same date. One male, eight females of lot (a), Tepic, Oct., '94, prove to be *Argia frequentula* Calvert, Biol. Centr.-Amer. Neur. 364, 365, 1907, although not listed there; 1♂, 4♀ in California Academy of Sciences, the remaining 4♀ in Academy of Natural Sciences of Philadelphia.

9. *Erythragrion salvum* Hagen, p. 383. (a) 8♂, 3♀; (b) 0; (c) 0.

10. *Ischnura ramburii* Selys, var. *credula* Hagen, p. 384. (a) 3♂, 1♀; (b) 0; (c) 0. There are 2 orange ♀ Tepic, Oct., '94, in the California Academy of Sciences, not listed in the paper of 1899.

11. *Gomphoides pacifica* Selys, p. 384. (a) 1♂, 1♀; (b) 0; (c) 0.

12. *Gomphoides suasa* Selys, p. 384. (a) 1♀; (b) 0; (c) 0.

13. *Cyclophylla elongata* Selys, p. 384. (a) 3♂; (b) 0; (c) 1♂ Oct., '94.

14. *Herpetogomphus viperinus* Selys, p. 385. (a) 3♂, 3♀; (b) 0; (c) 1♂, 1♀ Oct., '94.

15. *Herpetogomphus elaps* Selys, p. 386. (a) 13♂, 2♀; (b) 2♂ Oct., '94; (c) 3♂, 1♀ same date.

16. *Aeschna macromia* Brauer, p. 387. (a) 1♂; (b) 0; (c) 0.

17. *Aeschna* (group of *diffinis* Rambur), p. 387. (a) 1♀; (b) 0; (c) 0.

18. *Aeschna luteipennis* Burmeister, p. 387. (a) 1♂; (b) 0; (c) 0.

19. *Gynacantha*, sp. p. 387. (a) 1♀; (b) 0; (c) 0.

20. *Anax amazili* Burmeister, p. 387. (a) 1♀; (b) 0; (c) 0.

21. *Tramea onusta* Hagen, p. 387. (a) 1♀; (b) 0; (c) 0.

22. *Miathyria marcella* Selys, p. 388. (a) 5♂, 3♀; (b) 1♂ Nov., '94; (c) 2♂ same date.

23. *Pseudoleon superbus* Hagen, p. 389. (a) 1♂, 1♀; (b) 0; (c) 0.

24. *Orthemis ferruginea* Fabricius, p. 389. (a) 18♂, 12♀; (b) 0;, (c) 0.

25. *Dythemis velox* Hagen var. *sterilis* Hagen, p. 390. (a) 9♂, 15♀; (b) 0; (c) 0.

26. *Dythemis velox* Hagen, var. (?) *nigrescens* var. nov., p. 390. (a) 22♂, 32♀; (b) 5♂, 5♀ Oct., '94; (c) 5♂, 5♀ same date. I hereby designate one male and one female in the California Academy of Sciences as lectotype (C. A. S. No. 5610) and lectallotype (C. A. S. No. 5611) respectively of *nigrescens*.

27. *Brechmorhoga mendax* Hagen, p. 391. (a) 1♂, 1♀; (b) 0; (c) 0.

28. *Brechmorhoga postlobata* Calvert, p. 392. (a) 2♂; (b) 0; (c) 0. Both of these males presumably having been destroyed in the fire of 1906, without designation of type, I hereby designate the male from Mazatlan, Mexico, in the Museum of Comparative Zoology, Cambridge, Massachusetts, cited in the original description (Proc. Bost. Soc. Nat. Hist. 28 (12); 314, 1898) as the lectotype.

29. *Macrothemis pseudimitans* Calvert, p. 393. (a) 1♀; (b) 1♀ Nov., '94; (c) 0. See under No. 31 of the Baja California paper cited above.

30. *Macrothemis inequiunguis* Calvert, p. 394. (a) 2♂, 2♀; (b) 0; (c) 1♂, 1♀ Nov., '94. See under No. 32 of the Baja California paper cited above.

31. *Macrothemis inacuta* Calvert, p. 395. (a) 1♂; (b) 1♂ Oct., '94; (c) 0. A brief diagnosis of this species was first published in Proc. Bost. Soc. Nat. Hist. 28 (12) : 328, 1898. I hereby designate the male in the California Academy of Sciences as the lectotype (C. A. S. No. 5612).

32. *Trithemis basifusca* Calvert, p. 396. (a) 29♂, 16♀; (b) 0; (c) 0.

33. *Trithemis montezuma* sp. nov., p. 397. (a) 2♀; (b) 0; (c) 1♀ Oct. or Nov., '94, paratype, abdominal segments 5-10 lost; see Biol. Centr.-Amer. Neur. 252, 1906.

34. *Trithemis funerea* Hagen, p. 398. (a) 27♂, 24♀; (b) 3♂, 2♀ Nov., 1♀ Oct.; (c) 1♂, 1♀ Oct. or Nov., 1♂ Oct., 1♂, 1♀ Nov., all 1894.

35. *Micrathyria hagenii* Kirby, p. 399. (a) 2♀; (b) 0; (c) 0.

36. *Micrathyria æqualis* Hagen, p. 400. (a) 2♂, 6♀; (b) 0; (c) 0.

37. *Micrathyria* sp., p. 400. (a) 1♂; (b) 1♂ Nov., '94, "teneral and much damaged;" (c) 0. This Tepic male was listed as *Micrathyria schumanni* sp. n. [Calvert] in Biol. Centr.-Amer. Neur. 227, 1906; the holotype of

*schumanni* was designated therein, p. xxviii and explanations of pl. VIII, figs. 39, 40, pl. IX, fig. 24, as a male from Guadalajara in the Godman collection.

38. *Anatya normalis* sp. nov., p. 400. 1♂; 1♂ Nov., '94; 0. This male from Tepic, in the California Academy of Sciences (C. A. S. No. 5613), on which alone the description was based, is, *ipso facto*, the holotype of this species.

39. *Sympetrum illotum* Hagen, p. 401. (a) 2♂; (b) 0; (c) 0.

40. *Perithemis domitia* Drury, p. 402. (a) 21♂, 25♀; (b) 3♂, 3♀ Oct., '94; (c) 4♂, 3♀ same date.

41. *Lepthemis vesiculosa* Fabricius, p. 406. (a) 4♂, 1♀; (b) 0; (c) 0.

42. *Lepthemis verbenata* Hagen, p. 406. (a) 1♂; (b) 1♂ "no locality or date, probably Tepic;" (c) 0.

The following specimens, not listed in the Tepic paper, but from that locality, were subsequently identified and are in the California Academy of Sciences:

*Argia agrioides nahuana* Calvert, 1♂, 1♀, Biol. Centr.-Amer. Neur. 100, 1902.

*Enallagma cæcum* Hagen, 1♀ Oct., '94, Biol. etc., 113, 1902; subsequently referred to *E. cæcum novæ-hispaniæ* on page 381, of the same volume, 1907.

*Ischnura denticollis* Burmeister, 1♂, 1♀ Oct., '94, Biol. etc., 127, 1902.

*Anomalagrion hastatum* Say, 2♀, one orange, the other older, Oct., 94, Biol. etc., 130, 1903.

# INDEX TO VOLUME XXIII

FOURTH SERIES

New names in **bold-face** type

# ERRATA

Page 63. Line 22 from top: for *P. engelmanni* read *P. Engelmannii.*
Page 92. Line 8 from top: for **Eucynopstamus** read **Eucynopotamus.**
Page 189. Top line: for **Hyla aborea japonica** read **Hyla arborea japonica.**
Page 193. Lines 3 and 4 from bottom, left column: for *Mangilia* read *Mangelia.*
Page 193. Line 24 from top, left column: for *Gadina* read *Gadinia.*
Page 223. Line 6 from bottom: for **assimilata** read **assimillata.**
Page 276. Line 14 from bottom: for *Pontentilla* read *Potentilla.*
Page 277. Line 4 from bottom: for *Cryptanthe* read *Cryptantha.*
Page 287. Line 14 from top: for (*C. nivea Adams*) read (*C. nivea* Adams).
Page 444. Line 8 from top: for *Allobophora* read *Allolobophora.*