
FOR·THE·INCREASE·
AND·DIFFVSION·OF
KNOWLEDGE·AMONGMEN·
PER
ORBEM
·SMITHSONIAN·
·INSTITVTION·
·WASHINGTON·1846·

Division of Fishes

SMITHSONIAN INSTITUTION

UNITED STATES NATIONAL MUSEUM

PROCEEDINGS

OF THE

UNITED STATES NATIONAL MUSEUM

VOLUME XXXII

WASHINGTON

GOVERNMENT PRINTING OFFICE

1907

ADVERTISEMENT.

The scientific publications of the National Museum consist of two series—Proceedings and Bulletins.

The Proceedings, the first volume of which was issued in 1878, are intended primarily as a medium for the publication of original papers based on the collections of the National Museum, setting forth newly acquired facts in biology, anthropology, and geology derived therefrom, or containing descriptions of new forms and revisions of limited groups. A volume is issued annually or oftener for distribution to libraries and scientific establishments, and, in view of the importance of the more prompt dissemination of new facts, a limited edition of each paper is printed in pamphlet form in advance. The dates at which these separate papers are published are recorded in the table of contents of the volume.

The present volume is the thirty-second of this series.

The Bulletin, publication of which was begun in 1875, is a series of more elaborate papers, issued separately, and, like the Proceedings, based chiefly on the collections of the National Museum.

A quarto form of the Bulletin, known as the "Special Bulletin," has been adopted in a few instances in which a larger page was deemed indispensable.

Since 1902 the volumes of the series known as "Contributions from the National Herbarium," and containing papers relating to the botanical collections of the Museum, have been published as Bulletins.

CHARLES D. WALCOTT,
Secretary of the Smithsonian Institution.

JUNE 20, 1907.

TABLE OF CONTENTS.

[a] Date of publication.

[a] Date of publication.

[a] Date of publication.

[a] Date of publication.

[a] Date of publication.

[a] Date of publication.

LIST OF ILLUSTRATIONS.

TEXT FIGURES.

PLATES.

A SPECIMEN OF TYPICAL BURCHELL'S ZEBRA IN THE UNITED STATES NATIONAL MUSEUM.

By Marcus Ward Lyon, Jr.,

Assistant Curator, Division of Mammals, U. S. National Museum.

The United States National Museum is fortunate in possessing a good example of what is apparently a typical Burchell's zebra, *Equus burchellii* (Gray). According to a recent authority[a] this species is now extinct or nearly so, and it is desirable to publish photographic reproductions and descriptions of all specimens as a matter of permanent record. The specimen here described and illustrated[b] agrees very closely with the figures published by Mr. Pocock[c] and with the figure published by Mr. Ewart.[d] It is in many respects, however, different from Gray's original figure of *Asinus burchellii*,[e] mainly in the absence of shadow stripes anterior to the shoulder and the more complicated marking in the region of the rump and thigh. The specimen, Cat. No. 15120, U.S.N.M., was received in the flesh from the shows of Barnum, Bailey & Hutchinson from Bridgeport, Connecticut, on July 15, 1885. Unfortunately no other information regarding the specimen is obtainable. It was mounted for exhibition by Dr. W. T. Hornaday shortly after it was received at the Museum, and has since been on exhibition. The skull, Cat. No. 21982, U.S.N.M., and leg bones are, unfortunately, mounted in with the skin, and it does not seem advisable to remove the skull at present for purposes of study.

The scapulæ were the only other portions of the skeleton saved. In the catalogue the sex is marked "♂," but an examination of the specimen shows it to be a female, two teats being distinctly seen in the inguinal region. The specimen is in good condition aside from a

[a] Pocock, Proc. Zool. Soc. London, 1903, p. 196.

[b] A figure of the head and neck of this specimen was published in the Report of the U. S. National Museum, 1892, pl. LXXXI.

[c] Proc. Zool. Soc. London, 1903, p. 197.

[d] The Penycuik Experiments, 1899, p. 86.

[e] Zool. Journal, I, 1824–1825, pl. IX.

long oblique crack in the skin on the right side. The hair is slightly worn in spots about the shoulders and along the sides, where the animal had probably rubbed itself in its cage, as well as one or two minor spots about the head.

Markings.—The shape, direction, relative size, and number of the stripes and shadow stripes are well seen in the figures and need no detailed description. The most anterior shadow stripe subtends the first dorsal stripe posterior to the shoulder stripe on each side. No real stripes appear on the legs proper, but at the left heel are two small remnants of stripes, and about the right heel are three faint remnants. On the left side but one vertical dorsal stripe reaches the ventral longitudinal stripe, while on the right side two stripes are fully connected with the ventral line and a third is partially connected with it. The neck stripes are very broad, and on the right side some of them fuse in places.

Color.—The muzzle is dirty white, suffused with cream buff[a] just above margin of upper lip; elsewhere it presents a grizzled appearance, due to the dark bases of the hairs and the dark color of the skin showing through the short scant hairs. Chin similar to muzzle, but without any cream-buff area. The dark patches above the nostrils are intermediate in color between vandyke brown and burnt umber. The dark stripes on the face are dark seal brown tinged with vandyke brown; those on the cheeks a dark shade of vandyke brown and burnt umber. The light areas of the head are dirty white. The dark stripes of the neck and body are a dark combination of vandyke brown and burnt umber, growing lighter as the stripes reach the region of the elbow, belly, and hips. The upper half of the light neck stripes are a very light mixture of isabella and fawn colors, fading out to dirty white on the lower half of the stripes. The dark colors of the mane are concolor with the dark neck stripes, but the white areas are white or dirty white, contrasting with the isabella-fawn color of the upper portion of the neck stripes. The light stripes on the body, shoulders, hips, and thighs are a light mixture of fawn and isabella color; those on the body fading out to dirty white on the belly. The shadow stripes are light mummy brown, gradually blending into the ground color of the light stripes in which they are situated. The belly is dirty white, with the longitudinal stripe dark seal brown tinged with vandyke brown.

The legs are dirty white, irregularly suffused with dirty cream buff. The remnant of marks about the heel are similar in color to the shadow stripes, but much lighter.

The ears are dirty white; the dark spot toward the tip is concolor with the dark neck stripes.

[a] The names of the colors are taken from Ridgway's Nomenclature of Colors for Naturalists.

The tail is mainly dirty white, with the mid-dorsal stripe extending along its upper surface and gradually dying out near the end; tuft of hairs at the end dirty white, intermingled with a few brownish-black hairs.

Measurements.—Taken from mounted specimen. Total length, muzzle to end of tail vertebræ, tape applied to dorsal line, 2,740 mm.; length of head, muzzle to occiput, 510 mm.; occiput to shoulder stripe, 650 mm.; shoulder stripe to root of tail, 1,180 mm.; tail vertebræ, 440 mm.; tail to end of hairs, 725 mm.; height at shoulder, 1,115 mm.; tip of hoof to heel, 505 mm.; tip of hoof to elbow, 700 mm.; collosity, right foreleg, 75 by 30 mm.; collosity, left foreleg, 78 by 34 mm.; length of ear from meatus, 136 mm.; length of ear from crown, 152 mm.; length of hairs of mane at middle of neck, 103 mm.; antero-posterior diameter of forehoof where it is attached to skin, 84 mm.; greatest transverse diameter of same hoof at same point, 79 mm.; tip of hoof to base of hairs in front, 54 mm.; antero-posterior diameter of hind hoof where it is attached to the skin, 79 mm.; greatest transverse diameter of same hoof at same point, 64 mm.; tip of hoof to base of hairs in front, 60 mm.

EXPLANATION OF PLATES.

Plate I. Left side of Burchell's Zebra, *Equus burchellii* (Gray), Cat. No. 15120 U.S.N.M.

II. Right side of Burchell's Zebra, *Equus burchellii* (Gray), Cat. No. 15120 U.S.N.M.

III. Rear view of Burchell's Zebra, *Equus burchellii* (Gray), Cat. No. 15120 U.S.N.M.

EQUUS BURCHELLII ‘GRAY’. LEFT SIDE.

FOR EXPLANATION OF PLATE SEE PAGE 3.

EQUUS BURCHELLII (GRAY). RIGHT SIDE.

FOR EXPLANATION OF PLATE SEE PAGE 3.

EQUUS BURCHELLII (GRAY). REAR VIEW.

FOR EXPLANATION OF PLATE SEE PAGE 3.

REVISION OF THE AMERICAN MOTHS OF THE GENUS ARGYRESTHIA.

By August Busck,

Of the U. S. Department of Agriculture.

The genus *Argyresthia* was erected by Hübner[a] for four species, of which three are truly congeneric, and of which the first mentioned and best known (*Argyresthia goedartella* Linnæus) may be regarded as the type of the genus.

The genus includes a group of small moths of about half an inch or less in alar expansion, which are found principally in Europe and America. The different species exhibit great variety in the pattern of their wing ornamentation, but the ground color is nearly always white and the markings are either metallic golden or bronze or are brown and fuscous.

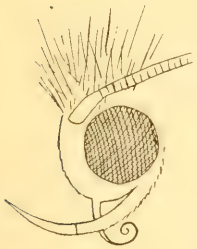


Fig. 1.—Head of Argyrestia.

They may be recognized by the following generic characters: Face smooth, head rough. Labial palpi porrected, moderately long, slightly curved and pointed; terminal joint long, both joints more or less roughened beneath. Maxillary palpi obsolete; tongue moderate. Antennæ three-fourths of wing-length, with rather long pectinated basal joint; in the males finely serrate and pubescent.

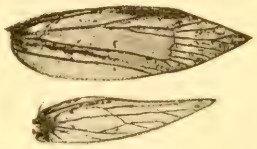


Fig. 2.—Venation of Argyresthia freyella.

Forewings elongate, pointed, smooth scaled with 12 veins (or with only 11 veins, one median vein being obsolete); 7 and 8 stalked or separate; 7 to termen; 1 b slightly furcate at base or simple; 2 from or near corner of cell, which is proportionally broad and which has an internal vein from between 11 and 10 to below 8 and another from base to between 4 and 5; membrane thickened along the costal edge above vein 11.

[a] Verz. bekant. Schmett, 1816, p. 422.

Hindwings narrower than the forewings, lanceolate with cilia 2–3; 8 veins (or sometimes only 7 veins, vein 4 absent, see page 10); 3 and 4 separate, connate or stalked; 5 and 6 stalked; 7 parallel to 6; 8 free; internal vein to stalk of 5 and 6; transverse vein sometimes more or less obsolete. Posterior tibiæ smoothly scaled.

The genus is nearest and correlated with *Zelleria* Stainton, which differs mainly in the absence of vein 4 in the hindwings.

From *Cedestis* Zeller it differs mainly in having veins 5 and 6 in the hindwings stalked instead of parallel.

The larvæ feed within leaves, shoots, buds, fruit, or bark, and pupate either in the mine or in a dense white cocoon outside the mine.

The moths assume at rest a characteristic position, apparently standing on their head, with the body and wings raised obliquely or sometimes nearly perpendicularly from the surface; before settling down to rest some of the American species at least execute a curious seesawing motion by balancing the body up and down with the second pair of legs as a pivot.

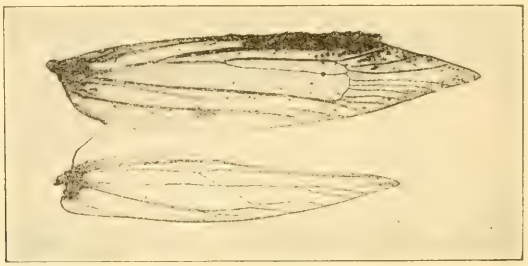


FIG. 3.—VENATION OF ARGYRESTIA GEODARTELLA.

Some of the species are occasionally numerous enough to be of some economic importance.

The genus *Argyresthia* is in the American Catalogue classed at present under the family Tineidæ, following Meyrick's system in his Handbook of British Lepidoptera, but, as before mentioned,[a] the writer is inclined to follow continental writers on this point, and regard the Argyrestidæ as a subfamily under the Yponomeutidæ, to which group they seem to be more allied than to the Tineidæ, notwithstanding the rough head, which on the whole appears to be of less fundamental importance, than has hitherto been given to that character.[b]

Some forty species of *Argyresthia* are known in Europe.

In the United States the genus was first recognized by Clemens, who in 1860 described one species. This species, *oreasella*, was at once wrongly determined by Stainton as the European *andereggiella* Duponchel, and has since remained obscured as a synonym of that species.

[a] Proc. U. S. Nat. Mus., XXVII, 1904, p. 754.

[b] Vide genus *Tamarrha* Walker, Busck, Proc. U. S. Nat. Mus., XXX, 1906, p. 729.

Of the true *andereggiella* I have not met with any American specimens, and the species should probably be excluded from our American List. It is included in the present paper on suspicion and in order to point out the differences of our *oreasella* Clemens.

Packard in 1871 described *Bucculatrix thuiella*, which now proves to be an *Argyresthia*.

Zeller in 1873 described three American species as follows: *quadristrigella*, *deletella*, and *austerella*, and identified wrongly a fourth species[a] as his European *abdominalis*, which name should be dropped from the American List.

Chambers described, during 1874–1877, seven species of *Argyresthia*—*undulatella*, *apicimaculella*, *belangerella*, *montella*, *quercicolella*, *altissimella*, and *pedmontella*—besides recording the European *goedartella* Linnæus. Of these Chambers himself made *undulatella* a synonym of Zeller's *austerella*, but, as the description and the types show, it is a good species and should be preserved.

Lord Walsingham described, in 1882 and 1890, four species in the present genus, namely, *subreticulata*, *cupressella*, *freyella*, and *plicipunctella*, of which *freyella* is the species wrongly identified by Zeller as the European *abdominalis*. He further recorded the European *mendica* Haworth from this country, but this record appears quite erroneous, as shown in detail under *Argyresthia rileiella*, new species (see p. 20), the type of which is the unique specimen on which the record of *mendica* was made, and *mendica* should thus be excluded from the American list.

Finally Riley recorded, in 1891, the European *pygmœella* Hübner from this country, and in 1896 Fletcher recorded the European *conjugella* Zeller, making 19 species rightly recorded from America, to which 5 new species are added in the present paper. Thus altogether 24 species of *Argyresthia* are known at the present time in this country, which number, however, will undoubtedly be considerably augmented, when the fauna is better known. These species may be distinguished by the help of the following analytical key, which, however, should be used with some caution, for the following reasons: (1) Because some of the species are quite close; (2) because the distinction between metallic golden and brown may be interpreted differently by other persons, especially as nearly all the species have a brilliant luster which might be described as metallic by some. Reference to the description and figure ought to make the determination reasonably certain.

I wish to acknowledge my obligations to Mr. T. W. Smillie, of the U. S. National Museum, for the excellent photographs from which the two accompanying plates are made. The photographs were taken from slides made by the writer, and thus represent the actual speci-

[a] The species later described as *freyella* Walsingham.

mens, in some cases the types, on which this paper is based. They will prove a valuable aid in the identification of the species under consideration.

Meyrick has grouped[a] the European species of *Argyresthia* according to whether they have veins 7 and 8 in the forewings stalked or separate. I am unable to class the American species by this character in any natural sequence, and believe the character quite unimportant as indicating natural groups; the stalked veins are generally found in the small species and the separate veins in the broader winged species irrespective of other affinities. Thus I can not recognize the propriety of the generic name *Blastotere* Ratzeburg, 1840, recently reintroduced and advocated by Lord Walsingham[b] for the species with veins 7 and 8 stalked, Meyrick's section A. The character, however, is constant within the species and may thus with advantage be an aid in determining the species. I have therefore noted the condition under the description of each species.

It is hoped that no American reference of any consequence has been omitted, but of European references only the original description and Standinger and Revel's Catalogue of European Lepidoptera are included.

ANALYTICAL KEY TO ARGYRESTHIA.

	Forewings with metallic golden or bronzy markings	1
	Forewings with nonmetallic brown or fuscous markings	13
1.	With four straight transverse fasciæ	*quadristriella* p. 9
	Without such fasciæ	2
2.	Thorax golden	3
	Thorax white	6
3.	With golden fasciæ	4
	Without fasciæ	5
4.	With forked central fascia	*gædartella* p. 12
	Without such fascia	*thoracella* p. 9
5.	Forewings with dark transverse striation	*deletella* p. 16
	Forewings without such	*cupressella* p. 10
6.	Head pure white	7
	Head golden ocherous white	*pygmæella* p. 13
7.	Markings dark brownish, at least at the edges	8
	Markings light yellowish	9
8.	With complete central fascia	*inscriptella* p. 15
	Without such	*oreasella* p. 14
9.	With black apical spot	10
	Without such spot	12
10.	Golden color diffused and prevailing	*freyella* p. 11
	White color prevailing markings sharp	11
11.	With forked central fascia	*annettella* p. 12
	Without such	*apicimaculella* p. 15
12.	Entire dorsal edge white	*subreticulata* p. 16
	Golden markings extending to dorsal edge	*quercicolella* p. 11

[a] Handbook of British Lepidoptera.

[b] Ent. Mo. Mag., XVII, p. 169, August, 1906.

13. Alar expanse half an inch or more 14
Alar expanse less than half an inch 17
14. Forewings with white dorsal path 15
Forewings uniformly lead colored ..... *altissimella* p. 17
15. With distinct dark dorsal spot 16
Without such spot ..... *montella* p. 19
16. Dark dorsal spot crossing white area ..... *conjugella* p. 17
Dark dorsal spot not crossing white area ..... *belangerella* p. 18
17. Ground color of costal part of forewings darker than dorsal part 18
Ground color of entire wing white 19
18. With dark brown dorsal streak ..... *rileiella* p. 20
Without such streak ..... *plicipunctella* p. 19
19. With complete transverse oblique fascia 20
Without such fascia 22
20. With large dark costal streak preceding the fascia ..... *austerella* p. 22
Without such costal streak 21
21. Basal part of costal edge suffused with brown ..... *undulatella* p. 22
Costal edge white ..... *bolliella* p. 21
22. Alar expanse 11–12 mm., veins 7–8 in forewings separate ..... *pedmontella* p. 21
Alar expanse 8–9 mm., veins 7 and 8 stalked ..... *thuiella* p. 23

ARGYRESTHIA QUADRISTRIGELLA Zeller.

Plate IV, fig. 1.

Argyresthia quadristrigella Zeller, Verh. zool. bot. gesell. Wien, XXIII, 1873, p. 304.—Frey and Boll, Stett. Entom. Zeitung, XXVIII, 1877, p. 209.—Chambers, Bull. U. S. Geol. Surv., IV, 1878, p. 130.—Dyar, Bull. 52, U. S. Nat. Mus., 1903, No. 6468.

Labial palpi whitish. Antennæ white annulated with black. Face and head light golden yellow. Thorax golden. Forewings golden white with the base, tip, and four nearly straightedged transverse fasciæ dark golden yellow. Cilia golden. Hindwings light gray. Forewings with veins 7 and 8 stalked.

Alar expanse.—10 mm.

A very characteristic species, which can not easily be confounded with any other and at once recognized by the golden thorax and the four sharply defined golden fasciæ. The type is in Museum of Comparative Zoology in Cambridge.

Habitat.—Texas (Boll).

Boll obtained his specimens of this species, among which the type, by beating *Juniperus virginiana* in March, and it is probable that this is the food plant of the species.

ARGYRESTHIA THORACELLA, new species.

Plate IV, fig. 2.

Labial palpi, face and head pure white; antennæ white with black annulations. Thorax light golden yellow. Forewings silvery pearly white with light golden markings as follows: A basal patch, a broad transverse fascia a basal third, somewhat wavy in outline and bulging

out in the middle toward apex; another much more undulating fascia on the middle of the wing with similar but exaggerated outline, and a third nearly straight fascia at apical third, sending out a zigzag line from its dorsal end into the apical part. No black apical dot. Hind wings whitish gray. Abdomen light ochreous. Legs silvery with tips of tarsal joints slightly blackened. Veins 7 and 8 in forewings stalked.

Alar expanse.—9 mm.

Habitat.—Williams, Arizona [H. S. Barber].

Type.—Cat. No. 9945, U.S.N.M.

Nearest to *A. cupressella* Walsingham, with clear white ground color and with lighter and more well-defined markings, which are nearly perpendicular on the edge, not strongly oblique as in *cupressella*.

ARGYRESTHIA CUPRESSELLA Walsingham.

Plate IV, fig. 3.

Argyresthia cupressella WALSINGHAM, Insect Life, III, 1890, p. 118—DYAR, Bull. 52, U. S. Nat. Mus., 1903, No. 6461.

Face and labial palpi yellowish white. Head white. Antennæ annulated with black. Thorax dark golden. Forewings with the white ground color suffused with light golden, and obscured by the diffused dark golden markings, which cover the base and the tip of the wing, and consist of an irregular, more or less broken, broad zigzag line touching both edges of the wing, and leaving only two or three dorsal and three or four costal spots of the whitish ground color exposed, giving the wing a checkered appearance. At the extreme apex is a minute black dot.

Forewings with only 11 veins—vein 3 absent and veins 7 and 8 stalked. Hindwing with vein 4 absent.

Alar expanse.—8–9 mm.

Foodplant.—*Cupressus.*

Habitat.—California (D. W. Coquillett).

I have examined the type of this species in Lord Walsingham's collection at Merton Hall, England. The series from which the type was taken was bred by Mr. Coquillett at Los Angeles, California, from twigs of several species of *Cupressus*. This series is in U. S. National Museum.

The forewings of this species have only four dorsal veins from the cell below the forked veins 7 and 8 and in the hindwing vein 4 is absent. It would, according to Meyrick's table, fall in the allied genus *Cedestis* Zeller, but this genus seems to me rather characterized by the parallel veins 5 and 6 in the hindwings than by the absence of veins in the forewings, and the present species is so closely allied to the nearest following species of *Argyresthia*, that I include it in this genus with its natural allies.

ARGYRESTHIA FREYELLA Walsingham.

Plate IV, fig. 4.

Argyresthia freyella Walsingham, Insect Life, III, 1890, p. 119.—Dyar, Bull. 52, U. S. Nat. Mus., 1903, No. 6462.

Argyresthia abdominalis Zeller [not of Europe], Verh. Zool. bot. Gesell. Wien, XXIII, 1873, p. 306.—Chambers, Bull. U. S. Geol. Surv., IV, 1878, p. 130.—Dyar, Bull. 52, U. S. Nat. Mus., 1903, No. 6453.

Labial palpi, face and head white; antennæ with brown annulations. Thorax white; patagina golden yellow. Forewings golden yellow, mottled with silvery white, as follows: A narrow basal central streak reaching to basal third; a small basal dorsal spot, two costal and two dorsal rather ill-defined outwardly oblique streaks meeting or nearly meeting at the center of the wing; a series of small costal and dorsal apical dots round the tip of the wing. Extreme apex black. Cilia golden yellow, with silvery base. Hind wings pale ochreous fuscous. Forewings with veins 7 and 8 stalked.

Alar expanse.—8–9 mm.

Foodplant.—*Juniperus.*

Habitat.—Texas (Boll), Missouri (U. S. Dept. Agr.).

I have examined the type of *freyella* at Merton Hall, England, and also Zeller's specimens of the supposed *abdominalis*, which are in the Museum of Comparative Zoology. There is, as suggested by Lord Walsingham, no doubt that they are identical but different from the true *abdominalis* of Europe, which thus should be excluded from our American list.

In the U. S. National Museum is a large series, compared with the type, bred in the insectary of U. S. Department of Agriculture from *Juniperus*, received from Cadet, Missouri.

This series was wrongly placed and labeled as *Bucculatrix thuiella* Packard. (See p. 23.)

ARGYRESTHIA QUERCICOLELLA Chambers.

Plate IV, fig. 5.

Argyresthia quercicolella Chambers, Bull. U. S. Geol. Surv., III, 1877, p. 130; IV, 1878, p. 130.—Dyar, Bull. 52, U. S. Nat. Mus., 1903, No. 6469.

Head, face and palpi white; antennæ annulated with black. Thorax white. Forewings silvery white, largely suppressed by the extensive golden-yellow markings which caused Chambers to regard that color as the groundcolor. The basal costal part of the wing is light golden and reaches on the costa out to a darker golden, inwardly oblique, broad fascia on the middle of the wing; this fascia is edged and partly overlaid with dark brownish scales on its dorsal half. The white groundcolor occupies the dorsal base of the wing and projects as a spur up along the central fascia nearly to the costal edge; it also

appears as a narrow basal central streak dividing the light golden color into two parts. The entire apical third, except two small dorsal and one small costal white spots, is golden-yellow sprinkled and edged with dark brown scales; the basal edge of this apical golden space is oblique and parallel with the central fascia, separated from it by a narrow, pure white, oblique fascia. Cilia golden with brown tips. Hindwings light fuscous. Forewings with veins 7 and 8 stalked.

Alar expanse.—10 mm.

Habitat.—Colorado (Chambers).

This species, the type of which is in the Museum of Comparative Zoology, is nearest *annettella* Busck (see p. 12), but larger and easily distinguished by the ornamentation.

Chambers collected this species among scrub oak in June, but the foodplant is only surmised to be oak.

ARGYRESTHIA ANNETTELLA, new species.

Plate IV, fig. 6.

Labial palpi, face, and head pure white; antennæ annulated with golden brown. Forewings silvery white with a pale golden crooked fascia from base of costa to basal third of dorsal edge; on the middle of the wing is a broad golden fascia, slightly furcate at the costal edge and at apical third is an irregular inwardly curved golden fascia with a golden costal streak preceding it and with two lobes into the apical part, one going to the costal and one to the dorsal edge. Extreme apex black; cilia golden. Hindwings light golden fuscous. Forewings with 7 and 8 stalked, one dorsal vein absent.

Alar expanse.—9 mm.

Habitat.—Cincinnati, Ohio (Miss Annette Braun).

Type.—Cat. No. 9946, U.S.N.M.

This species is nearest to *goedartella* Linnæus in wing markings, but much smaller than that species and differing in details of the pattern.

Named in honor of the collector, Miss Annette F. Braun, who has sent me this and many other interesting microlepidoptera, all in the most attractive condition and setting.

ARGYRESTHIA GOEDARTELLA (Linnæus.)

Plate IV, fig. 7 and text fig. 2.

Tinea goedartella Linnæus, Syst. Nat., 1758, p. 541

Argyresthia goedartella Auctores, Staudinger and Rebel Cat. Lep. Eur., II, 1901, No. 2402.—Chambers, Can. Ent., VII, 1875, p. 144; VIII, 1876, p. 19.

Argyresthia goedastella Chambers, Cinn. Quart. Journ. Science, II, 1875, p. 294; Bull. U. S. Geol. Survey, III, 1877, pp. 131, 141, 147; IV, 1878, p. 130.—Saunders, Can. Ent., VII, 1878, p. 220.

Argyresthia goedertella Dyar, Bull. 52, U. S. Nat. Mus., 1903, No. 6458.

Labial palpi, face, and head golden white; antennæ white with black annulations. Thorax pale golden. Forewings shining white with golden reflections, sometimes suffused with pale golden; an outwardly oblique, somewhat curved coppery-golden fascia from base of costa; another similarly colored on the middle of the wing is strongly furcate at costa, and a third inwardly oblique fascia at apical third, parallel with the outer fork of the second fascia, emits a lobe into the apical part of the wing, sometimes connecting with the coppery-golden apex. Hindwings dark gray. Forewings with veins 7 and 8 separate.

Alar expanse.—11–13 mm.

Foodplant.—Catkins and shoots of birch and alder (Meyrick).

The American specimens, which, without hesitation, I refer to this species, as Lord Walsingham and others have done before, average slightly larger than the European specimens and the color of the head and thorax is somewhat lighter than in the European series at my command.

Chambers recorded the species from Colorado. In the U. S. National Museum are, in addition to a good European series (Hoffmann collection), specimens from California, determined by Lord Walsingham, and a large series collected by Doctor Dyar on alder in British Columbia; also specimens from Center Harbor, New Hampshire (Dyar), and from Pecos, New Mexico (Cockerell).

ARGYRESTHIA PYGMÆELLA Hübner.

Plate IV, fig. 8.

Argyresthia pygmæella HÜBNER, Schm. Eur., 1827, p. 353.—STAUDINGER and REBEL, Cat. Lep. Eur., II, 1901, p. 2419.—RILEY, Smith's List Lep. Bor. Am., 1891, No. 5175.—DYAR, Bull. 52, U. S. Nat. Mus., 1903, No. 6467.

Labial palpi, face, and head golden white; antennæ annulated with brown. Thorax golden-white; patagina golden. Forewings white suffused with pale golden; a darker golden streak on the fold from base to a golden dorsal spot at basal third; an outwardly oblique golden streak from the middle of the dorsal edge reaches beyond the middle of the wing and at tornus is a golden spot. Hindwings fuscous. Forewings with veins 7 and 8 separate.

Alar expanse.—12–14 m. m.

This striking species was first recorded from America by the late Prof. C. V. Riley. In the U. S. National Museum are specimens from British Columbia (Dyar) and from Seattle, Washington (Kincaid), which I can not differentiate from the European series of this species.

ARGYRESTHIA OREASELLA Clemens.

Plate IV, fig. 9.

Argyresthia oreasella Clemens, Proc. Acad. Nat. Science, Phila., 1860, p. 7; Stainton's ed. Tin. N. Am., 1872, pp. 39, 93.—Chambers, Can. Ent., VI, 1874, p. 10.—Busck, Proc. Wash. Ent. Soc., V, 1903, p. 193.

Argyresthia andereggiella Zeller (not Duponchel) Ver. Zool. bot. Gesell. Wien, XXIII, 1873, p. 304.—Chambers, Can. Ent., VII, 1875, p. 145; Bull. U. S. Geol. Survey, IV, 1878, p. 130.—Dyar, Bull. 52, U. S. Nat. Mus., 1903, No. 6455.

Argyresthia anduegiella Chambers, Bull. U. S. Geol. Surv., III, 1877, pp. 131, 141.

Labial palpi silvery white; face faintly tinged with golden; head white; antennæ white, with dark-brown annulations. Thorax white. Forewings silvery white, with a pale golden streak from base of costa diverging slightly from costal edge; from the middle of the dorsal edge runs a broad golden fascia, somewhat outwardly oblique, across the wing, tapering strongly toward costa, which it hardly reaches, but where it is substituted by two minute golden-brown dots. From costa, just beyond these dots, and nearly touching the tip of the first fascia, runs a narrower, outwardly oblique golden fascia to tornus; this fascia emits from its middle a broad branch toward apex, which divides into three smaller branches, two of which reach the costal and one the dorsal edge; all the golden markings except the basal streak are edged with dark-brown scales; around apical edge is a narrow brown line before the cilia, which is dark-golden fuscous. Hindwings dark gray. Forewings with veins 7 and 8 separate.

Alar expanse.—13 mm.

It is with some reluctance that I must disagree with all former writers on this species, among whom are such careful workers as Stainton and Zeller, who have made this species a synonymn of the European *andereggiella* Duponchel. I was led to accept this synonomy in a former paper[a] by trusting to the determination of several American specimens in U. S. National Museum, which were collected and named by Lord Walsingham; but critical study of a large series of European specimens shows definite and constant differences in the ornamentation between the European and the American forms, and Clemens's name therefore should be retained for the latter.

In the U. S. National Museum are specimens of this species, collected and determined by Lord Walsingham, from Mount Shasta, California; also specimens from Cornwall, Idaho (Piper); New York, Beutenmüller; Missouri (Miss Murtfeldt), Ontario (Hanham), and Beulah, New Mexico (Cockerell).

Chambers recorded the species from Colorado, where he took it among oaks, and as Miss Murtfeldt's specimens also were captured

[a] Proc. Wash. Entom. Soc., V, 1903, p. 196.

on oak, this may eventually prove the food plant of the species. Of *Argyresthia andereggiella* Duponchel, I know no American specimens, and it should properly be excluded from our American faunal list, as its record seems to be made only on misidentified specimens. There is, however, a possibility that the species may have been or will be introduced, and I give the figure of the wing from authentic European specimens (Plate IV, fig. 10) for comparison with *oreasella*.

ARGYRESTHIA INSCRIPTELLA, new species.

Plate IV, fig. 11.

Palpi and face light golden; head pure white; antennæ white, with brown annulations. Thorax white. Forewings silvery white, with dark golden or bronze-brown markings, as follows: Costal edge from base to the middle of the wing suffused with light brown; from the middle of the costa a broad, inwardly oblique, dark golden-brown fascia, with two or three small white notches on the costal edge; entire apical third strongly overlaid with dark golden-brown scales, except for three costal white dashes, two dorsal and several minute apical white dots. The apical dark part of the wing is separated from the central fascia by a large triangular pure white spot, which rests with one side on the dorsal edge and from the opposite upper corner emits a narrow line upward to a white costal dash. Hindwings rather dark fuscous. Legs silvery white, with tips of all joints brown. Forewings with veins 7 and 8 stalked.

Alar expanse.—8 mm.

Habitat.—Williams, Arizona, July (Barber).

Type.—Cat. No. 9947, U.S.N.M.

A very strikingly marked little species, easily recognized from the figure of the wing.

ARGYRESTHIA APICIMACULELLA Chambers.

Argyresthia apicimaculella Chambers, Can. Ent., VI, 1874, p. 11.—Bull. U. S. Geol. Surv., IV, 1878, p. 130.—Dyar, Bull. 52, U. S. Nat. Mus., 1903, No. 6456.

Argyresthia visaliella Chambers, Can. Ent., VII, 1875, p. 145.

Shining silvery-white, each joint of the antennæ (except the basal one) dotted above with dark brown. Primaries with a blackish or dark-brown, shining, almost triangular spot at the apex, with three pale and indistinct brownish costal streaks before it; the first of these streaks is the shortest and most indistinct and is placed at the beginning of the cilia. The second is a little more distinct and sometimes extends entirely across the wing and the third one always does so after dividing into two branches just before the apical spot. These streaks are usually more or less interrupted and sometimes spread over the apex, so that it might perhaps be more correctly described as dusted

than streaked. There is a bright though pale golden basal streak just within the costal margin.

Alar expanse.—$\frac{3}{8}$ inch (about 10 mm.). Kentucky, in oak woods, in June and July.

The above is Chambers's original description. The species is unknown to me except from a single specimen in poor condition in Museum of Comparative Zoology, received from Chambers. This specimen is glued on a card point and is labeled *A. visaliella;* it undoubtedly represents the present species, which should be easily recognized from the description, when met with.

ARGYRESTHIA SUBRETICULATA Walsingham.

Plate IV, fig. 12.

Argyresthia subreticulata WALSINGHAM, Trans. Am. Ent. Soc. Phila., X, 1882, p. 173.—DYAR, Bull. 52, U. S. Nat. Mus., 1903, No. 6470.

Labial palpi golden-white. Face and head silvery-white. Antennæ annulated with light golden-brown. Thorax white. The dorsal two-thirds of the forewings pure immaculate white from base to shortly before apex. The costal third from base to apex light golden-brown, in the apical part somewhat darker and reticulated with white. The dark part of the wing broadens slightly and gradually toward apex and reaches to the apical third of the dorsal cilia. Around the apical edge is a narrow dark bronze line. Apical cilia golden, dorsal cilia white. Hindwings light gray. Forewings with veins 7 and 8 stalked.

Alar expanse.—9 mm.

Habitat.—Pennsylvania.

The type of this very distinct species is in the collection of the Philadelphia Academy of Natural Sciences. It is easily distinguished from all described American species of the genus by the large immaculate dorsal part of the forewings.

ARGYRESTHIA DELETELLA Zeller.

Plate V, fig. 1.

Argyresthia deletella ZELLER, Verh. Zool. bot. Gesell. Wien, XXIII, 1873, p. 305.—CHAMBERS, Bull. U. S. Geol. Surv., IV, 1878, p. 130.—DYAR, Bull. 52, U. S. Nat. Mus., 1903, No. 6463.

Labial palpi and face golden-white. Head white. Antennæ with black annulations. Thorax light golden yellow. Forewings whitish yellow, darker on the costal and apical parts than below the fold and irregularly sprinkled with small indistinct brownish transverse streaks. On the middle of the dorsal edge is a poorly defined brown transverse marking, crossing the light dorsal part and reaching beyond the fold. Apical cilia brownish with white base; dorsal cilia light ocherous.

Hindwings light ocherous gray. Veins 7 and 8 in the forewings stalked.

Alar expanse.—10 mm.

Habitat.—Texas.

The species is nearest *A. pedmontella* Chambers, but differs from it by its ocherous coloration and is easily recognized by the brown transverse striation.

The types are in the Museum of Comparative Zoology and in Lord Walsingham's collection. In U. S. National Museum is an identical specimen, which I have compared in both these places and which I believe belongs to the original type series.

ARGYRESTHIA ALTISSIMELLA Chambers.

Argyresthia altissimella Chambers, Bull. U. S. Geol. Surv., III, 1877, pp. 130, 147; IV, 1878, p. 130.—Dyar, Bull. 52, U. S. Nat. Mus., 1903, No. 6454.

I quote Chambers' description:

Of a leaden hue, except that the vertex is whitish, the antennæ annulated with white; the palpi are a little darker than the general hue, except the under surface of the second joint, which is whitish. Cilia paler than the wings. Expanse of wings scant 6 lines (about 12 mm.). In some lights the forewings appear silvery or pale golden. Taken in July among dwarf willows on the side of Mount Elbert, Colorado. Altitude 11,000 feet.

This species is unknown to me except from the unique type in the Museum of Comparative Zoology, on which I made the following note in October, 1902:

Type No. 1412, unique, labeled Colorado; in rubbed condition. Probably a true *Argyresthia*, but different from any known to me; forewings, which are much rubbed, appear to have been uniformly golden fuscous, with strong metallic reflexions.

Closer study of this type is required, but if, as I believe, it belongs to the present genus, the species should be easily recognized when met with.

ARGYRESTHIA CONJUGELLA Zeller.

Plate V, fig. 2.

Argyresthia conjugella Zeller, Isis, 1839, p. 204.—Fletcher, Rept. Entom. Can. Agricult. Dept., 1896, p. 258; 1897, p. 201; 1898, p. 198.—Staudinger and Rebel, Cat. Lep. Eur., 1901, No. 2393.—Lampa, Entom. Tidsek., XXVII, 1906, p. 1.

Palpi, face, and head yellowish-white; antennæ annulated with dark brown. Thorax yellowish-white; patagina dark brown. Forewings dark purplish-brown with dorsal part to tornus white; on the middle of the dorsal edge is an outwardly oblique blackish-brown streak, which loses itself in the dark costal part. Costal edge is strigulated with yellowish white, and shortly before apex is a larger white costal dash. Apical cilia blackish-brown; dorsal cilia ocherous fuscous.

Hindwings dark fuscous with ocherous-gray cilia. Forewings with veins 7 and 8 separate.

Alar expanse.—12–13 mm.

Food plants.—Berries of *Sorbus aucuparia* (authorex), fruit of apple (Fletcher, Lampa).

This European insect, whose normal food plant is mountain ash, has of late years been observed in Canada and Scandinavia to attack cultivated apples whenever the normal food supply for any reason has failed, and it has thereby proved itself a very destructive enemy of the apple crop of considerable economic importance.

Dr. J. Fletcher first recorded the species and its change of food plant from British Columbia. One of his specimens determined by Lord Walsingham and Mr. Durrant, in 1897, is in U. S. National Museum; it is labled: Apple-fruit miner, British Columbia, Jan. 2, 1897.

Another specimen from Fieldbrook, California (H. S. Barber), can not be distinguished from typical European specimens in the Museum collection.

Prof. S. Lampa has recently (see reference above) given a very excellent review of this insect with an account of his own careful observations on its habits on *Sorbus* and on apple; it is illustrated by a fine colored plate.

ARGYRESTHIA BELANGERELLA Chambers.

Plate V, fig. 3.

Argyresthia belangerella Chambers, Can. Ent., VII, 1875, p. 145; Bull. U. S. Geol. Surv., IV, 1878, p. 130.—Dyar, Bull. 52, U. S. Nat. Mus., 1903, No. 6460.

Palpi white; head and face white; antennæ with dark brown annulations. Thorax white; patagina dark brown. Costal part of forewing above the fold dark brown, with a series of still darker costal spots from the middle to apex, the outer ones intersected with white dashes. Dorsal part of the wing below and somewhat beyond the folds ocherous white, with a semicircular, not very well defined, dark brown spot on the middle of the dorsal edge and a smaller one at apical third. Cilia light brown. Hindwings dark fuscous. Legs white, shaded with brown. Forewings with veins 7 and 8 separate.

Alar expanse.—13 mm.

Habitat.—Canada.

The type of this species, from Professor Belanger's collection, was obtained by the writer with the other of Chambers's types in that collection through the courtesy of Rev. Dr. C. E. Dionne of the Laval University, Quebec, Canada, and it is now in U. S. National Museum as type No. 5777.

An identical cotype, received from Chambers, is in the Museum of Comparative Zoology.

The species is very near *conjugella* Zeller, but differs by the dorsal dark spot not reaching the costal dark part of the wing.

ARGYRESTHIA MONTELLA Chambers.

Argyresthia montella CHAMBERS, Bull U. S. Geol. Surv., III, 1877, p. 130; IV, 1878, p. 130.—DYAR, Bull 52, U. S. Nat. Mus., 1903, No. 6464.

Face and palpi yellowish; tuft and thorax white; antennæ fuscous, annulated with white; forewings fuscous, the apical portion indistinctly dusted with white, and with indistinct short white streaks before the apex, each dark margined before; the dorsal margin is white as far as the fold, and very faintly dusted; no dorsal fuscous streak; there is a row of fuscous scales around the base of the cilia, which at the apex have, to the naked eye, the appearance of a minute spot. Hindwings, cilia, and upper surface of the abdomen pale grayish; undersurface of the wings grayish fuscous and tuft whitish; legs whitish, the tarsi stained with yellowish.

Expanse of wings.—7 lines [about 15 mm.]. Among scrub-oaks at Edgerton [Colorado] in July.

The above is Chambers description; the species is known to me only from the unique type [No. 1411] in Museum of Comparative Zoology on which I made the following note in 1902:

Near *belangerella*, but larger, and without the dark dorsal spot in the white part of the wing; with an extreme apical black line as in *pedmontella*, from which it also differs by the absence of the dorsal streak.

ARGYRESTHIA PLICIPUNCTELLA Walsingham.

Plate V, fig. 4.

Argyresthia plicipunctella WALSINGHAM, Insect Life, III, 1890, p. 119; IV, 1891, p. 386.—DYAR, Bull. 52, U. S. Nat. Mus., 1903, No. 6465.

Labial palpi, face, and head white, antennæ annulated with brown. Thorax white, patagina light fuscous. Forewings white, suffused, and sprinkled with grayish brown, especially in costal and apical parts, while the dorsal part below the fold is nearly pure white. Around the apical edge is a not very prominent darker line and on the fold is a rather indistinct, somewhat darker brownish spot, not touching the dorsal edge. Hindwing light ocherous fuscous. Legs white, tarsal joints slightly tipped with brown. Forewing with veins 7 and 8 stalked.

Alar expanse.—10 mm.

Habitat.—California and Oregon.

I examined the types of this species at Merton Hall, England, and obtained through the liberality of my hosts one of the cotypes from Mendocino County, California, from which the present description and figure is made. It is an obscure, poorly marked species, which, however, can not well be mistaken for any of the other described forms.

ARGYRESTHIA RILEIELLA, new species.

Plate V, fig. 6.

Argyresthia mendica WALSINGHAM [not Haworth], Insect Life, III, 1891, p. 118.—DURRANT, Rept. of Entomologists, Can. Dept. Agricult., 1897, p. 202.—DYAR, Bull. 52, U. S. Nat. Mus., 1903, No. 6459.

Head, face, and palpi white; antennæ annulated with golden brown. Thorax white, patagina dark golden brown. Forewings white, above the fold strongly suffused with golden brown especially toward apex, which is quite dark; along the outer half of the costal edge is an irregular series of ill-defined small darker brown spots intervened with whitish. The dorsal edge below the fold is nearly immaculate white until the middle of the wing, where it is cut off by a large ill-defined dark brown patch, which crosses the fold and gradually widens out and is lost in the dark portion of the wing. Hindwings light ocherous fuscous. Legs white, tarsal joints tipped with brown. Forewings with veins 7 and 8 separate and one dorsal vein absent.

Alar expanse.—9 m m.

Habitat.—Washington, District of Columbia (Riley), May, 1885.

Type.—Cat. No. 9948, U.S.N.M.

Lord Walsingham erroneously recorded the European *Argyresthia mendica* Haworth on the unique specimen in National Museum, which I have now made the type of *rileiella*. The specimen is only in fair condition, and I should not have described the species until more material was on hand except for the correction of this record; it is certainly distinct from *mendica*, a figure of which (Plate V, fig. 5) I give for comparison, it being smaller, more slender winged, and without the white costal markings characteristic of the European species; this latter of course must be dropped from our faunal list.

It is also quite distinct from *conjugella*, which species it was suggested it might be by Mr. H. Durrant, who, with Lord Walsingham, had realized, that the determination *mendica* was probably erroneous.[a]

Rileiella is nearest to *pedmontella*, but is a smaller, more shining species in which the costal part is darker and the dorsal part more immaculate white than in *pedmontella*. It differs from all three species by the absence of one dorsal vein in the forewing.

Named in honor of the collector, the late Prof. C. V. Riley, to whose special interest in Microlepidoptera we owe much valuable work done by himself and others in this group.

[a] Durrant, Rept. Entom. Can. Dept. Agricult., 1897, p. 202.

ARGYRESTHIA PEDMONTELLA Chambers.

Plate V, fig. 7.

Argyresthia pedmontella CHAMBERS, Bull. U. S. Geol. Surv., III, 1877, p. 131; IV, 1878, p. 130.—DYAR, Bull. 52, U. S. Nat. Mus., 1903, No. 6466.

Labial palpi, face and head white; antennæ annulated with brown. Thorax white, patagina brown. Forewings white, strongly suffused with dark brown on the costal and apical parts; dorsal part below the fold only slightly sprinkled with dark scales; on the costal edge from basal third to apex is an irregular series of darker brown spots intervened by pure white dashes; around apex and along base of dorsal cilia is a thin blackish-brown line, and on the middle of the dorsal edge is a large, oblique, dark brown spot shaped like a parallelogram reaching across the light dorsal area to the more densely dusted costal part. Cilia light fuscous. Hindwings light fuscous. Legs shaded with dark brown. Forewings with veins 7 and 8 separate.

Alar expanse.—13 mm.

Habitat.—Colorado (Chambers).

This is nearest to *belangerella* and *rileiella*, differing from both in the lighter costal part of the forewing and in the form of the dorsal spot.

ARGYRESTHIA BOLLIELLA, new species.

Plate V, fig. 8.

Labial palpi and face golden white; head white; antennæ with dark-brown annulations. Thorax and patagina white. Forewings white, with dark-brown markings as follows: A broad, inwardly oblique, dark-brown fascia from beyond the middle of the costal edge, sometimes narrower, and diffused on the middle of the wing, but reaching and widening out on the dorsal edge; a large, ill-defined dorso-apical spot, covering apical fourth except along costal edge, which is white; a series of small, irregular brown streaks along the costal edge and a sparse sprinkling of brown scales on the entire wing; sometimes a larger dot on dorsal edge before the fascia. Hindwings dark fuscous. Legs golden white; tarsal joints shaded with brown. Forewings with veins 7 and 8 separate.

Alar expanse.—10–11 mm.

Habitat.—Texas (Boll).

Type.—Cat. No. 9949, U.S.N.M.

Named in honor of the collector, the late Jacob Boll, whose beautifully preserved specimens, collected more than a quarter of a century ago, are still among the most valuable material in the few important collections of American Microlepidoptera.

The species is nearest to *undalatella* Chambers, but somewhat larger, without the bastal costal dark streak and with the fascia reaching across the wing to the dorsal edge.

ARGYRESTHIA UNDULATELLA Chambers.

Plate V, fig. 9.

Argyresthia undulatella CHAMBERS, Can. Ent., VI, 1874, p. 10; VII, 1875, p. 145.
Chalciope undulatella CHAMBERS, Can. Ent., VI, 1874, p. 10.
Polyxo undulatella CHAMBERS, Can. Ent., VI, 1874, p. 10.
Albunea undulatella CHAMBERS, Can. Ent., VI, 1874, p. 10.
Argyresthia austerella CHAMBERS (not Zeller), Can. Ent., IX, 1877, p. 72; Bull. U. S. Geol. Surv., IV, 1878, p. 130.—DYAR, Bull. 52, U. S. Nat. Mus., 1903, No. 6457 (part).

Labial palpi white, shaded externally with brown. Face white below, brownish above. Head white. Antennæ annulated with black. Thorax and patagina white. Forewings white, with base of costal edge brownish and with costal and apical parts rather freely dusted with brown scales; from beyond the middle of costa runs a dark brown fascia inwardly oblique, which does not quite reach the dorsal edge; at apical third is a similar, but not so well defined, oblique dark brown streak, which is connected with and diffused into the nearly brown apical part of the wing in which are two or three white costal dashes and a thin black line along the apical edge. Hindwings light fuscous. Legs white, tarsi annulated with brown. Forewings with veins 7 and 8 stalked.

Alar expanse.—9 mm.

Habitat.—Kentucky (Chambers).

This species was made a synonym of Zeller's *austerella* by Chambers himself, though he noted the differences of his species from Zeller's very striking figure of *austerella*, and it has since been regarded as such; but Chambers's description and a comparison of his and Zeller's type in the Museum of Comparative Zoology and in the U. S. National Museum clearly proves that the two species are distinct, and Chambers's old name must be revived.

The most striking difference from *austerella* is the total absence of the first costal dark streak at basal third, found in Zeller's species.

ARGYRESTHIA AUSTERELLA Zeller.

Plate V, fig. 10.

Argyresthia austerella ZELLER, Verh. zool. bot. Gesell. Wien, XXIII, 1873, p. 305.—CHAMBERS, Bull. U. S. Geol. Surv., IV, 1878, p. 130.—DYAR, Bull. 52, U. S. Nat. Mus., 1903, No. 6457.

Labial palpi white, shaded with fuscous. Face lead colored. Head white. Antennæ white, with black annulations. Thorax white. Forewings white, with striking dark-brown marking; entire costal edge and apical part of the wing mottled with dark brown, in which the ground color appears as small dots and dashes, especially in the apical part.

Before the middle of costa is a dark brown, nearly black, inwardly oblique streak reaching to the fold; from just beyond the middle of costa runs a broader blackish brown fascia parallel with the first costal streak, but reaching to the costal edge, though somewhat attenuated. At apical third is a third dark streak parallel to the other two, but generally more or less diffused into the dark apical part of the wing. Legs golden white, annulated with black. Forewings with veins 7 and 8 stalked.

Alar expanse.—8–9 mm.

This boldly marked species is nearest to the two foregoing, but, as indicated under them, quite distinct, as Zeller's figure alone proves.

Zeller's types are in the Museum of Comparative Zoology; they came from Texas (Boll). In the National Museum are identical specimens from Cincinnati, Ohio, by Miss A. F. Braun, and near St. Louis, Missouri, and on Plummers Island, Maryland, by the writer.

ARGYRESTHIA THUIELLA Packard.

Plate V, fig. 11.

Bucculatrix thuiella Packard, Amer. Nat., V, 1871, p. 152; Rept. U. S. Entom. Com., V, 1890, p. 917.—Riley, Rep. Ins. Mo., IV, 1872, p. 51.—Dyar, Bull. 52, U. S. Nat. Mus., 1903, No. 6250.

Argyresthia sp., Fletcher, Rept. of Entom. Can. Dept. Agr., 1905, p. 189.

Palpi, head, and face white, antennæ with brown annulations. Thorax white. Forewings pearly white with brown markings; base of costal edge light golden brown; at basil third is a small brown dorsal streak; on the middle of the wing is a larger brown dorsal streak, sometimes reaching nearly to an opposite small brown costal spot, but generally diffused and interrupted before then; at apical third is a nearly complete narrow brown fascia and around the apical edge is a series of small dark-brown dots. These markings are quite variable and often much diffused; in some specimens the entire basal half is nearly immaculate white and the markings confined to the gradually darker apical spots; in other specimens the entire wing is slightly sprinkled with irregular ill-defined brown spots. Hindwings, light fuscous. Legs yellowish white. Veins 7 and 8 in the forewings stalked.

Alar expanse.—8–9 mm.

Habitat.—Maine (Packard), Canada (Fletcher), Pennsylvania (Dietz).

Foodplant.—*Thuja occidentalis.*

This neat little species can not easily be confused with any other described American Argyresthia, in spite of the variation in markings. A very large series was lately bred by the writer from *Thuja* branches sent from Dr. J. Fletcher, Ottawa, Canada. The larvæ mines the terminal shoots, leaving them dead and discolored, and Doctor Fletcher stated that the species did considerable damage in his neighborhood to ornamental *Thuja*, as was also very evident from the material sent.

The larva pupates within the mine without much of a cocoon, and the adults go through the characteristic undulating motion before settling down to the typical position of rest.

I have very little hesitation in identifying this species as the one described by Packard as a *Bucculatrix* for the following reasons: No species of *Bucculatrix* is known to feed on evergreens; the description fits the present species very well, as does the figure, which, although poor, looks like an *Argyresthia*, but could hardly have been drawn from a *Bucculatrix*. Packard had rather vague ideas of the genera of Microlepidoptera, as is abundantly proven by his description of *Nepticula pomivorella* as a *Micropteryx*, and of *Tinea fuscipunctella* Haworth as *Oecophora frigidella;* a large number of the small, very peculiar parasite *Pentacnemus bucculatricis* Howard, which was described from Packard's specimens, were also bred from my material; the cocoons which Packard described and associated with his species did, according to his description, not look like those of a *Bucculatrix* and probably belonged to the *Recurvaria thuyella*, common on the same plant and also bred from Doctor Fletcher's material.

However, there is, of course, a possibility of a *Bucculatrix* feeding on *Thuja*, and if such is ever found Packard's name must revert to that species; but I consider this very improbable.

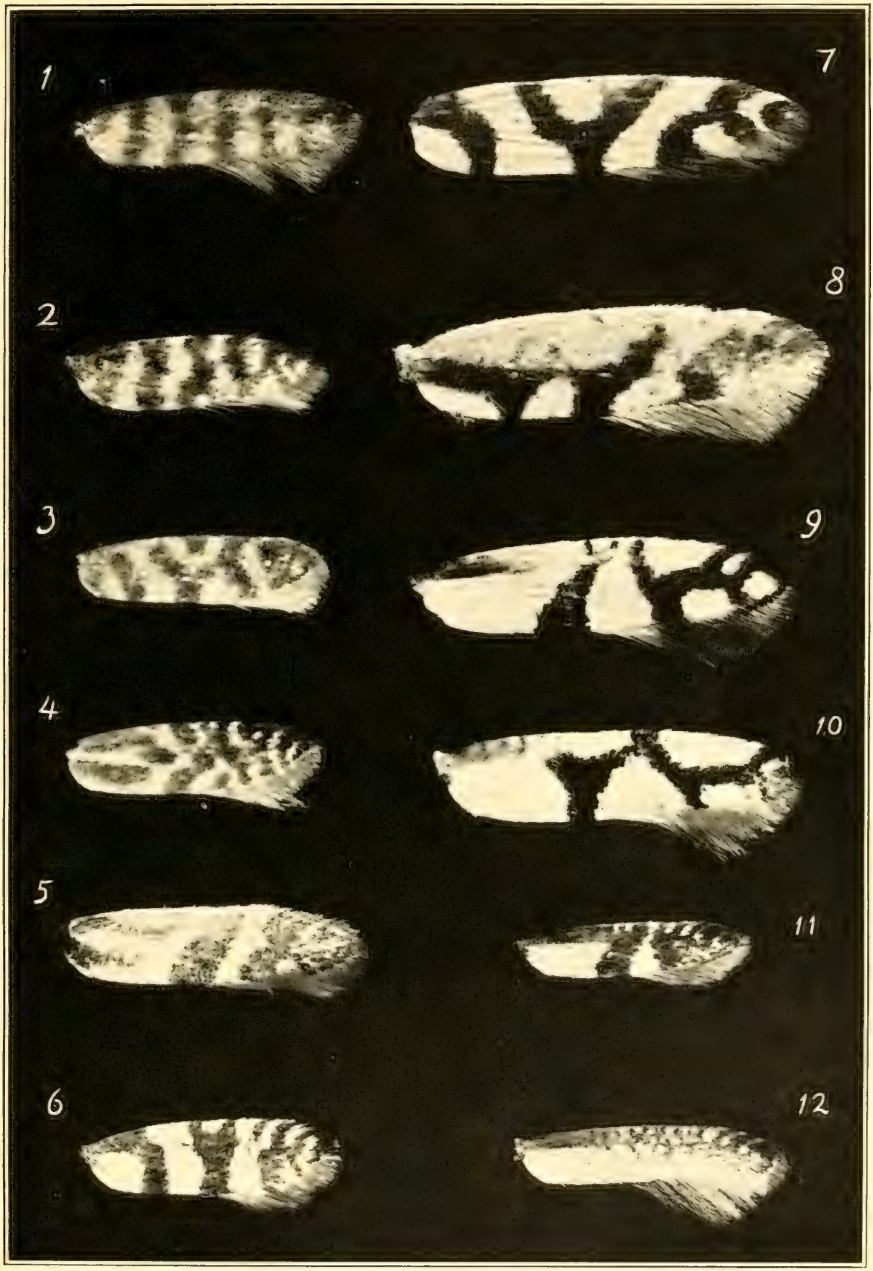
EXPLANATION OF PLATES.

PLATE IV.

FIG. 1. *Argyresthia quadristrigella* Zeller.
2. *Argyresthia thoracella* Busck.
3. *Argyresthia cupressella* Walsingham.
4. *Argyresthia freyella* Walsingham.
5. *Argyresthia quercicolella* Chambers.
6. *Argyresthia annettella* Busck.
7. *Argyresthia goedartella* (Linnæus).
8. *Argyresthia pygmæella* Hübner.
9. *Argyresthia oreasella* Clemens.
10. *Argyresthia andereggiella* Duponchel.
11. *Argyresthia inscriptella* Busck.
12. *Argyresthia subreticulata* Walsingham.

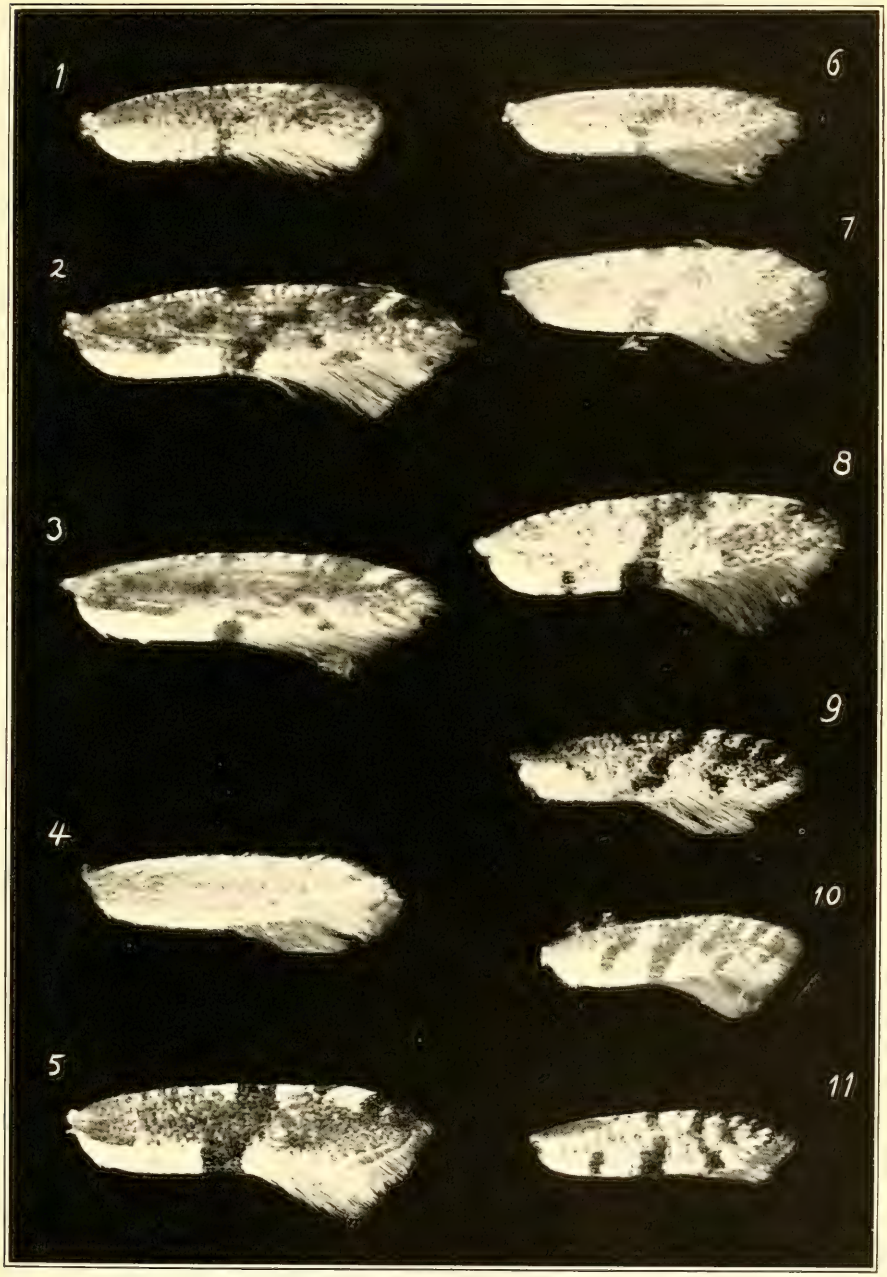
PLATE V.

FIG. 1. *Argyresthia deletella* Zeller.
2. *Argyresthia conjugella* Zeller.
3. *Argyresthia belangerella* Chambers.
4. *Argyresthia plicipunctella* Walsingham.
5. *Argyresthia mendica* Haworth.
6. *Argyresthia rileiella* Busck.
7. *Argyresthia pedmontella* Chambers.
8. *Argyresthia bolliella* Busck.
9. *Argyresthia undulatella* Chambers.
10. *Argyresthia austerella* Zeller.
11. *Argyresthia thuiella* Packard.



WINGS OF THE GENUS ARGYRESTHIA.

FOR EXPLANATION OF PLATE SEE PAGE 24.



WINGS OF THE GENUS ARGYRESTHIA.

FOR EXPLANATION OF PLATE SEE PAGE 24.

THE FRESH-WATER AMPHIPODA OF NORTH AMERICA.

By Ada L. Weckel,
Of Moline, Illinois.

All the species of Amphipoda known to occur in the fresh waters of North America were described by Prof. Sidney I. Smith in his report on the Crustacea of the Fresh Waters of the United States, published in 1874. Previous to that report practically no work had been done on the fresh-water forms belonging to this group. Since then many new species have been described, and the present paper is intended to include descriptions of all of the species of Amphipoda now known to occur in the fresh waters of North America. Only two species are here described for the first time, but as I have had the opportunity of examining specimens in some cases the types—of most of the known forms, it was thought best to redescribe and figure them.

The genera and also the species, in several instances, were in a state of confusion; consequently an extensive synonymy of each species described has been included. A bibliography has also been added which lists the principal papers dealing with the amphipod fauna of the region covered by this paper.

I am greatly indebted to Dr. S. J. Holmes, of the University of Wisconsin, under whose direction this work was conducted, for many courtesies received during the preparation of this paper. My thanks are due also to Prof. S. A. Forbes for the loan of a large collection of material from the Illinois State laboratory of natural history. A large number of specimens were obtained from the United States National Museum, and the valuable aid thus received is gratefully acknowledged.

KEY TO FAMILIES AND GENERA.

A. First antennæ with secondary flagellum; fifth peræopods shorter than preceding; two rami of third uropods nearly equal; second gnathopods smaller than first ..... Lysianassidæ. *Pontoporeia*, p. 26.

AA. First antennæ with secondary flagellum; fifth peræopods longer than the preceding; second gnathopods generally larger than the first ..... Gammaridæ

B. Telson cleft; uropods biramous.

C. Inner ramus rudimentary; telson cleft not more than three-fourths distance to base.

D. Outer ramus of third uropods uniarticulate ..... *Eucrangonyx*, p. 29
DD. Outer ramus of third uropods biarticulate ..... *Niphargus*, p. 36
CC. Inner ramus not rudimentary, one-half to three-fourths as long as outer, which is biarticulate; telson cleft to the base, or nearly so ..... *Gammarus*, p. 38
BB. Telson entire.
C. Third uropods with rami.
D. Third uropods uniramous; telson short and broad ..... *Crangonyx*, p. 49
DD. Third uropods biramous. Inner ramus rudimentary, outer uniarticulate; last two segments of urosome coalescent ..... *Stygonectes*, p. 51
CC. Third uropods without rami ..... *Apocrangonyx*, p. 53
AAA. First antennæ without secondary flagellum; telson entire, short and broad; third uropods uniramous ..... ORCHESTIIDÆ; *Hyalella*, p. 54

Family LYSIANASSIDÆ.

Only two species, *Pontoporeia hoyi* Smith, and *Pontoporeia filicornis* Smith, have been described as belonging to this family. I have not had specimens of either, but will quote Professor Smith's descriptions of them.

Genus PONTOPOREIA Krøyer.

KEY TO SPECIES.

A. Antennæ not reaching to the posterior end of the abdomen; outer ramus of third uropods not more than twice as long as the peduncle ..... *P. hoyi*, p. 26
AA. Antennæ extending to or beyond the tip of the abdomen; outer ramus of the third uropods more than twice as long as the peduncle ..... *P. filicornis*, p. 28

PONTOPOREIA HOYI Smith.

Gammarus brevistylis STIMPSON, MSS. (female).
Pontoporeia affinis SMITH, Am. Jour. Sci., 3rd. ser., II, 1871, p. 453; Prelim. Rep. on Dredgings in Lake Superior, 1871, p. 1022.
Pontoporeia hoyi SMITH, Rep. U. S. Fish Com., 1872–73, (1874) p. 647, pl. II, fig. 5.

Professor Smith's description follows:

On first examining specimens of this species, obtained in Lake Superior in 1871, I regarded them as specifically identical with the *Pontoporeia affinis* of the Scandinavian lakes and the Baltic. A subsequent and more minute comparison has, however, revealed some differences, which are apparently constant. In the form and proportions of the segments of the thorax and abdomen, in the size and form of the eyes, in the minute details of antennulæ, antennæ, and mouth appendages, I can detect no differences by which it would be possible to distinguish specimens taken in Lake Superior from those sent from Lake Wetter, or from the beautiful figures of the Scandinavian species given by Sars.[a] In the first pair of legs, however, the propodus in the American species is proportionately a very little shorter than in the European, and the palmary margin is less oblique—that is, it is not so nearly parallel with the posterior margin; the posterior margin is somewhat shorter, and furnished with fewer hairs; and there are usually two small and slender spines on the palmary margin near the tip of the closed dactylus, while in the European species there are no real spines upon the palmary margin, but only slender setiform hairs. In both the European and American species, there is a very thin and narrow lamellar edge,

[a] Histoire Naturelle des Crustacés d'Eau Douce de Norvège, 1867, p. 82, pl. VII, figs. 10–25; pl. VIII, figs. 1–5.

extending nearly the whole length of the palmary margin. The dactylus is apparently a little longer and more slender in the European species. The obliquity of the palmary margin, and its armature near the posterior angle, seem to be always characteristic of the American species. In the young specimens, however, there is often but one spine, while in larger ones there are often three. In the third and fourth pairs of legs of the American species the dactylus is usually armed on the inside, a little way from the tip, with two setiform hairs, while in the European species there is only one. Some young specimens of the American species, however, agree with the European in having but one hair upon the dactylus, while large ones often have three, and in the full-grown male from Lake Michigan, mentioned farther on, there are even four.

The most remarkable differences are in the peculiar, elongated, papilliform appendages upon the sternal portion of the thoracic segments. In the European species, Dr. G. O. Sars describes and figures an elongated and slender process depending from the middle of the sternum of several of the thoracic segments; and in the single specimen which I have examined, there are three of these processes, one each on the second, third, and fourth segments. Dr. Sars, who has studied the living animals very carefully, does not suggest what may be the use of the appendages, or whether they ever vary in number or position in different specimens. In specimens from Lake Superior there are usually seven of these appendages, one upon the second and

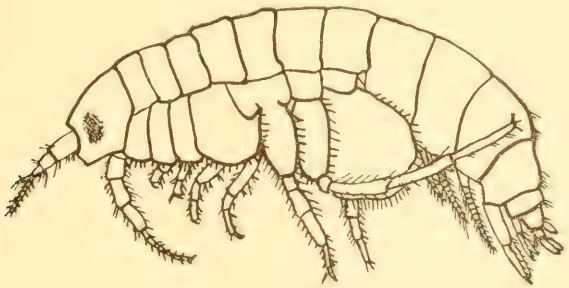


FIG. 1.—PONTOPOREIA HOYI. (After Smith.)

two each upon the third, fourth, and fifth segments. In form and size, these appendages do not differ, except that in alcoholic specimens they seem to be a little longer in the American species. In some specimens of the American species, the appendage upon the second segment is wholly wanting, and in two specimens examined carefully there was only a single median one upon the third segment. In the absence of all knowledge of the nature and use of these appendages, it seems useless to speculate on their importance as distinctive characters. In a species of *Pontoporeia* from the Gulf of St. Lawrence, which I suppose to be the *P. affinis* of Kroyer, there are no such appendages on any of the thoracic segments. This fact, together with the variation noticed in the specimens from Lake Superior, would seem to indicate that these appendages are not of so much importance as might at first be supposed.

This species was found in great abundance in the dredgings in Lake Superior in 1871, and occurred in every haul from 4 to 169 fathoms. It was also dredged by Mr. J. W. Milner in Lake Superior in 1872, in 60 fathoms off Outer Island. It is common in the stomach of the whitefish from Lakes Superior and Michigan, and probably also from the lower lakes. All the specimens dredged in Lake Superior were taken in August and the early part of September, and none of the females were carrying eggs during that time. Females carrying eggs were dredged by Dr. Stimpson, in Lake Michigan, in 40 to 60 fathoms, off Racine, Wis., June 24, 1870, and with them the adult male form with long antennulæ and antennæ. This peculiar

form of the adult male, corresponding perfectly with the same form of the European species figured and described by Dr. Sars, I have not been able to find among the numerous specimens from Lake Superior. A single specimen of this form of the male was, however, sent to me by Dr. Stimpson under the manuscript name of *Gammarus Hoyi*, while two specimens of the female were sent as *Gammarus brevistylis*. These are undoubtedly the same as the *Gammarius Hoyi* and *brevistilus* mentioned, without description, by Dr. P. R. Hoy. [a]

PONTOPOREIA FILICORNIS Smith.

Gammarus filicornis STIMPSON, MSS.
Pontoporeia filicornis SMITH, Rep. U. S. Fish Com., 1872–73 (1874), p. 649.

Professor Smith's description follows:

Male.—Outline of the head very much as in *P. affinis*. Eyes about as large as in that species, slightly elongated, black. Peduncle of the antennula reaching nearly to the distal end of the penultimate segment of the peduncle of the antenna, about as long as the head and the first segment of the thorax together; first segment large and thickened; second half as long as the first; third slightly more than half as long as the second. Flagellum greatly elongated and very slender, reaching nearly to the tip of the abdomen, and composed of thirty-three segments, of which the proximal are longer than broad, while they increase in length distally, until, near the tip, they are many times longer than broad, and exceedingly slender. The upper side of the flagellum is nearly naked, only the alternate segments being furnished with two minute setæ near the distal extremity, while the under side of each segment is armed distally with minute setæ, and most of the segments with one or several clavate (olifactory) papillæ, and many of the segments have in addition a peculiar transparent, shallow, bell-shaped appendage, raised on a very slender peduncle. Secondary flagellum reaching to the fourth segment of the primary, and composed of four segments, of which the terminal one is very short. Penultimate segment of the peduncle of the antenna about as long as the first segment of the peduncle of the antennula; ultimate segment slightly shorter; penultimate and antepenultimate segments furnished with long, plumose hairs below and several fascicles of short, setiform hairs above. Flagellum much longer than the flagellum of the antennula, very slender, and composed of about fifty very elongated and somewhat flattened segments, which have about the same proportions as in the flagellum of the antennula, and are furnished with the same kinds of appendages.

Epimera of almost exactly the same proportions and form as in *P. affinis*, and the first four margined with plumose hairs in the same way. First pair of legs very nearly like those of *P. affinis;* the palmary margin even slightly more longitudinal than in that species, continuous with the posterior margin, and armed with two small obtuse spines near the tip of the closed dactylus in addition to the setiform hairs. Second pair of legs of the same form as in *P. affinis*, except that the palmary margin is slightly concave and a little oblique in a proximal direction; the posterior margin furnished with fascicles of setiform hairs, as in that species, and armed close to the palmary margin with three or four small obtuse spines. Third and fourth pairs of legs like those of *P. affinis*, except that the dactyli have each three setiform hairs near the tip, being in this as in several other respects nearer *P. Hoyi*. Fifth and sixth pairs of legs almost exactly as in *P. affinis*, except the posterior margin of the propodus in the sixth pair is armed with three pairs of small spines. Seventh pair of legs having a few small spines on the propodus, but otherwise as in *P. affinis*.

Lateral margins of the first second, and third segments of the abdomen with the angles rounded; lateral margin of the third segment furnished with a line of several submarginal, plumose setæ near the anterior angle, and behind them armed with five large and acute spines directed backward, of which four are in pairs near the middle of

[a] Deep Water Fauna of Lake Michigan, Trans. Wis. Acad. Sci., 1870–72, p. 98–101.

the margin, and one alone near the posterior angle; the posterior edges of the lateral expansions of all three of the segments furnished with a few, widely separated, plumose hairs. Peduncles of the first and second pairs of caudal stylets reaching to about the same point, a little beyond the extremity of the sixth segment of the abdomen; the outer rami slightly longer than the inner, and those of the second pair of stylets only a little shorter than those of the first. Rami of the posterior caudal stylets longer than in *P. affinis;* the outer ramus rather more than twice as long as the peduncle, narrow, and tapering to an obtuse tip, both edges furnished with long plumose hairs, and the outer edge with a sharp spine at the base of each hair. Telson slightly longer than broad, cleft half-way to the base, and each lobe tipped with two short spinules and a plumose seta. There are two of the peculiar papilliform appendages on the sternum of the third, fourth, and fifth segments of the thorax, as in *P. Hoyi*, but apparently none upon the second.

* Length from the front of the head to the tip of the telson, 6 mm.

Of this species, I have seen but a single specimen, which was dredged with the last species in Lake Michigan in 40 to 60 fathoms, off Racine, by Dr. Stimpson, from whom it was received under the manuscript name of *Gammarus filicornis.*

This species differs remarkably from all the heretofore-known species of *Pontoporeinæ*, in the excessive elongation of the flagella of the antennulæ and antennæ, a character which might be regarded by some naturalists as of generic value. The very close agreement with *P. affinis* and *Hoyi* in all other parts of the animal, however, seems to indicate a very close affinity with those species, especially the latter; and as this one peculiarity is very likely only a sexual character of the old males of the species, I retain the species in the genus. The mouth-appendages seem to agree perfectly with those of the species just mentioned. The singular armature of the lateral margins of the third segment of the abdomen is not peculiar to this species, but is almost exactly repeated in *P. affinis, P. Hoyi*, and the marine species, already mentioned, from the Gulf of St. Lawrence, and is probably common to the genus, although it seems to have been overlooked till now.

Family GAMMARIDÆ.

Genus EUCRANGONYX Stebbing.

KEY TO SPECIES.

A. Telson about as long as peduncle of third uropods, not deeply cleft, third uropods short.
  B. Outer ramus of third uropods about twice the length of peduncle; inner ramus very small, telson cleft one-third distance to base.
    C. Eyes small, elongated, with black pigment ..... *E. gracilis*, p. 32
    CC. Eyes small without black pigment ..... *E. packardii*, p. 35
  BB. Outer ramus of third uropods shorter than peduncle; inner ramus absent, peduncle produced distally on the inner side into a short, blunt process; telson cleft three-fourths distance to base ..... *E. bifurcus*, p. 33
AA. Telson in the male elongated, equaling from one-fourth to one-third length of body, rounded distally; telson in female short, with a slight emargination; third uropods with short outer ramus and rudimentary inner ramus, *E. mucronatus*, p. 29

EUCRANGONYX MUCRONATUS (Forbes).

Crangonyx mucronatus Forbes, Bull. Ill. State Lab. Nat. Hist., No. 1, 1876, p. 6.—O. P. Hay, Am. Nat., XVI., 1882, p. 241.

Eucrangonyx mucronatus Stebbing, Trans. Linn. Soc. London, 2nd ser., VII, 1899, p. 423.

Bactrurus mucronatus W. P. Hay, Proc. U. S. Nat. Mus., XXV, 1902, p. 429.

Blind. Head slightly longer than the first thoracic segment, concave on its anterior margin at the bases of the first antennæ and convex between them. First antennæ in the male half to two-thirds as long as the body; in the female about half as long as the body; flagellum four or five times as long as the peduncle and consisting in the male of about thirty-five segments, all but the first seven or eight of which are provided with slender olfactory clubs; secondary flagellum slightly longer than the first segment of the primary one (usually shorter in the female) and composed of two segments, the distal one very short. Second antennæ only about one-half as long in the first

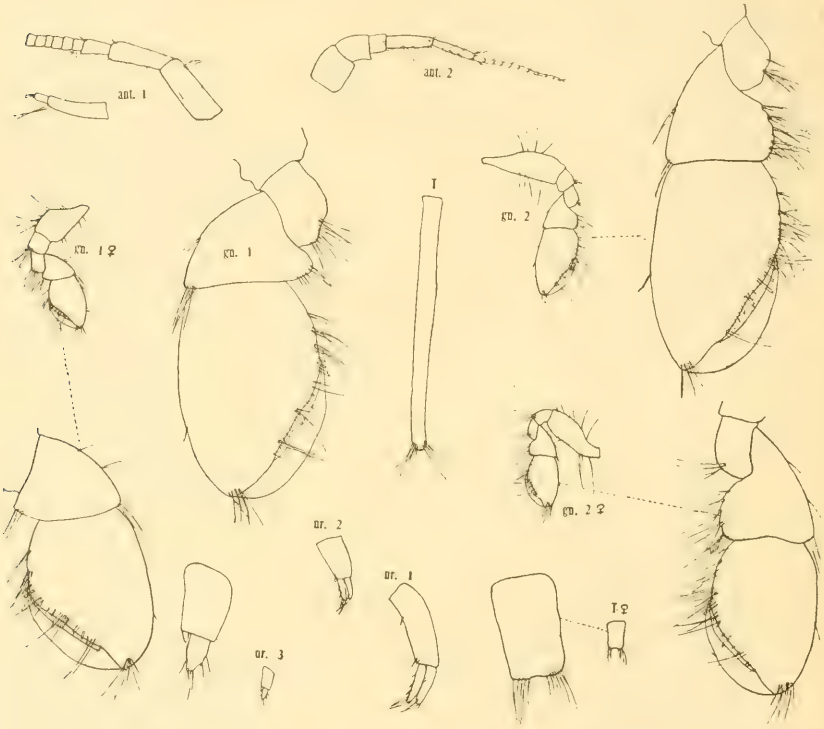


FIG. 2.—EUCRANGONYX MUCRONATUS. *ant.* 1, FIRST ANTENNA; *ant.* 2, SECOND ANTENNA; *gn.*, GNATHOPOD; *T.*, TELSON; *ur.*, UROPOD; *gn.* 1 ♀, *gn.* 2 ♀, AND *T.* ♀ FROM A FEMALE; OTHER FIGURES FROM A MALE.

pair; peduncle extending beyond that of the first pair; the two distal segments elongated, about equal in length; flagellum slightly shorter than the peduncle and composed of about ten segments.

In the male the carpus of the first gnathopods is broadly triangular, fully as broad as the propodus; propodus about two-thirds as broad as long; anterior and posterior margins only slightly convex, the posterior furnished with three small fascicles of long hairs; palm very oblique, slightly concave at the center, with a broad lamellar edge, furnished with two or three fascicles of long hairs, and about ten notched

spines, with usually two large spines near the center and three at the tip of the closed dactyl; dactyl strongly curved, slightly longer than the palm. First gnathopods of the female with the propodus smaller, shorter, and broader distally than in the male.

In the second gnathopods the carpus is slightly longer than broad; much larger than in the first pair; propodus not much larger than in the first pair and not so broad; the posterior and anterior margins only very slightly convex, the posterior furnished with more hairs than in the first pair; palm longer than in the first pair, similarly armed, but having a few more spines; dactyl strongly curved, as long as the palm. Propodus of the second gnathopods in the female not so much elongated as in the male, but similarly armed.

Coxal plates of the three posterior peræopods oval, not large, with both margins serrated.

Abdominal segments rounded dorsally; the lateral margins and all the angles broadly rounded.

The first pair of uropods extend beyond the second pair, which extend beyond the third; second pair not longer than the peduncle of the first; third pair short, not quite so long as the peduncle of the second pair; outer ramus ovate, truncate, about half the length of the peduncle, provided distally and laterally with a few hairs; inner ramus rudimentary, unarmed, about one-third or one-fourth as long as the outer ramus.

Telson in the male cylindrical, very much elongated, equaling from one-fourth to one-third the length of the body, rounded distally, and furnished with two clusters of long hairs. In the female the telson is short, projecting beyond the tips of the third uropods, having a very slight emargination, on either side of which there is a cluster of long, stout hairs.

Length, 10–15 mm.

Collected in old wells at Irvington, Indiana; Champaign and Normal, Illinois.

The telson in the female of this species is somewhat incised posteriorly, but less than is usual in this genus; in the male the telson is entire and greatly elongated, a feature which does not accord with the definition of the genus as originally given by Stebbing. The other characters of this species, however, are so much like those of the other members of this genus that it seems best to retain it in the genus *Eucrangonyx*, to which it was assigned by Stebbing, rather than to place it in a new genus, *Bactrurus*, as proposed by Hay.

EUCRANGONYX GRACILIS (Smith).

Crangonyx gracilis Smith, Am. Jour. Sci., 3d ser., II, 1871, p. 453; Prelim. Report on Dredgings in Lake Superior, 1871, p. 1022; Rep. U. S. Fish Com., 1872–73, (1874) p. 654.—Forbes, Bull. Ill. State Lab. Nat. Hist., No. 1, 1876, p. 6.—O. P. Hay, Am. Nat., XVI, 1882, p. 241.—W. P. Hay, Proc. U. S. Nat. Mus., XXV, 1902, p. 429.

Eucrangonyx gracilis Stebbing, Trans. Linn. Soc. London, 2d ser., VII, 1899, p. 423.

Eyes small, elongated. First antennæ slightly more than half as long as the body; peduncle with the first segment shorter than the second, which is about twice as long as the third; flagellum twice as long as the peduncle and consisting of about thirty segments; secondary flagellum about equal in length to the first segment of the primary

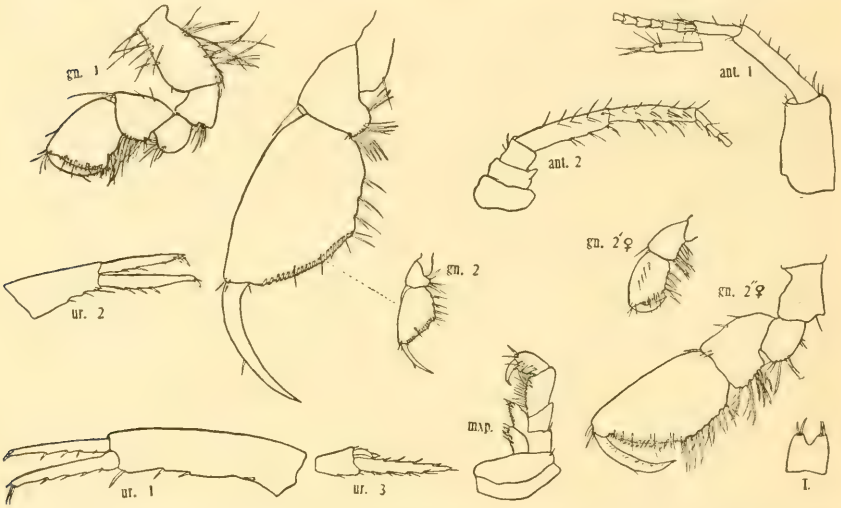


Fig. 3.—Eucrangonyx gracilis, Ann Arbor, Michigan. *mxp.*, maxilliped; for other inscriptions to this and succeeding figures see fig. 2. *gn.* 2′♀, second gnathopod of a small female; *gn.* 2″♀, second gnathopod of a large female. Maxilliped drawn to a larger scale than the other parts.

one, composed of two segments, the terminal one slender and very short. Second antennæ half as long as the first pair; ultimate and penultimate segments of the peduncle nearly equal; flagellum somewhat shorter than the peduncle and composed of eight to ten segments.

Carpus of the first gnathopods in the male about as broad as long; the posterior margin produced but slightly and furnished with long plumose hairs; propodus almost quadrate in outline, a little longer than broad; palm convex, slightly oblique, and armed on each side with from ten to fifteen notched spines, which are equidistant from each other except at the posterior angle, where about five are crowded together; each spine is furnished with a hair a short distance from the tip; the posterior margin slightly concave, with a few long hairs;

dactyl stout, slightly curved, extending to the posterior margin of the palm.

Carpus of the second gnathopods in the male like that of the first pair; propodus more elongated than in the first pair, broadened distally; palm oblique, somewhat arcuate, armed with fifteen or more spines similar to those of the first pair, but not crowded into a group at the posterior angle; posterior margin of hand with five or six groups of hairs; dactyl strongly curved, as long as the palm. In the female the propodus of the second gnathopods is proportionally more elongated than in the male and does not increase in breadth distally.

Third, fourth, and fifth peræopods with the coxal plates serrate, and with small spines on both margins.

Postero-lateral angles of the first three segments of the abdomen produced, terminating in a small tooth.

First pair of uropods projecting backward beyond the second and third pairs, two rami equal and about two-thirds as long as the peduncle; second pair with rami equal, and equal in length to the peduncle; third pair short, reaching to the tip of the second pair, peduncle short; outer ramus about twice the length of the peduncle, inner ramus very small, slender, shorter than the peduncle, usually without spines or hairs. Telson slightly shorter than the peduncle of the third uropods; about as broad as long, cleft about one-third the distance to the base with two or three spines on the truncate extremities of the lobes.

The specimens of this species differ greatly in size, varying in mature specimens from 7–18 mm., but the larger ones agree in all essential features with the smaller.

Distribution.—Providence, Rhode Island; Ann Arbor and Isle Royal, Michigan; Lake Huron; Lake Superior; Portage, Wisconsin; Champaign, Illinois; Irvington, Indiana; Delaware, Ohio; Nashville, Tennessee.

This species can not belong to the genus *Crangonyx* to which it was assigned by Smith. That genus as generally defined has the third uropods uniramous and the telson entire. The new genus *Eucrangonyx*, in which this species has been placed by Stebbing, is like *Crangonyx* in general, but with a small inner ramus to the third uropods and with the telson emarginate.

EUCRANGONYX BIFURCUS (O. P. Hay).

Crangonyx bifurcus O. P. Hay, Am. Nat., XVI, 1882, pp. 145–146.

Eyes oval, large, about twice as large as those of *Eucrangonyx gracilis* which this species resembles. First antennæ not quite half the length of the body; third segment of the peduncle two-thirds as long as the first or second segments, which are nearly equal; flagellum

composed of about twenty-five elongated segments; secondary flagellum slightly shorter than the first segment of the primary flagellum, consisting of two segments, the distal one short; entire antennæ furnished with comparatively few short hairs. Second antennæ slightly more than half as long as the first pair; two distal segments of the peduncle elongated, nearly equal in length, the third segment short; flagellum not so long as the two distal segments of the peduncle, composed of about six elongated segments; antennæ furnished with a few hairs and a number of large olfactory clubs.

Carpus of the first gnathopods in the male short and broadly triangular, nearly as broad as the propodus; propodus slightly longer than

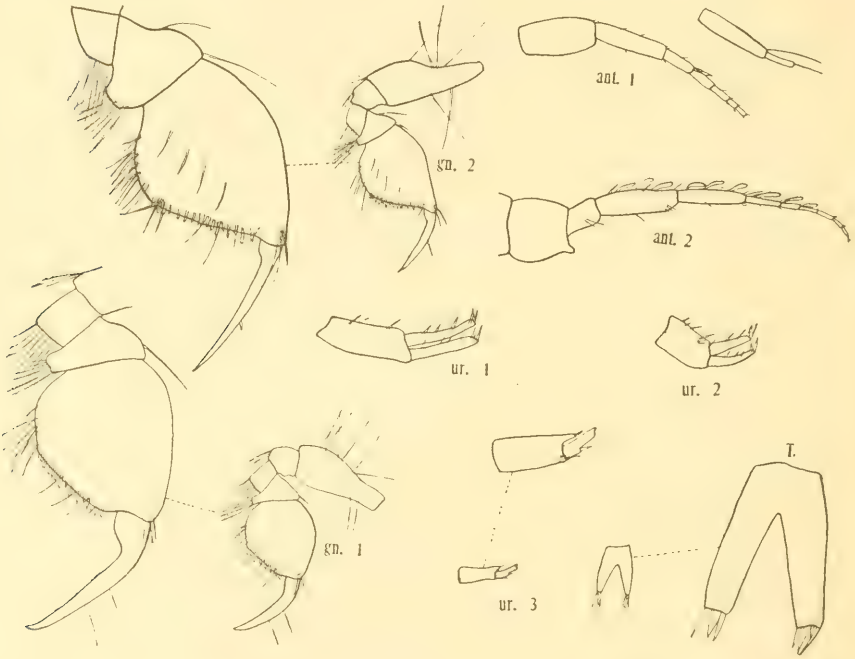


FIG. 4.—EUCRANGONYX BIFURCUS, MALE. MACON, MISSISSIPPI.

broad; lateral margins convex, the posterior provided with four or five small fascicles of hairs; palm oblique, armed on each side with about twelve spines and a few hairs; dactyl strongly bent near the base, as long as the palm. Second gnathopods with the carpus and propodus very similar to those of the first pair, but more elongated; the palm more oblique, armed with about fifteen notched spines; posterior margins furnished with six small fascicles of hairs.

Last three pairs of peræopods with the coxal plates oval, both margins serrate and armed with small spines.

Abdominal segments rounded dorsally; postero-lateral angles of the first three segments produced backward into a tooth.

First uropods projecting backward beyond the second pair, and the second beyond the third; third pair consisting of a peduncle and a single small ramus; peduncle more than twice as long as broad, furnished with a few spines, and produced distally on the inner side into a short, blunt process furnished at the tip with a small spine; ramus about two-thirds the length of the peduncle, provided with a few spines. Telson cleft three-fourths the distance to the base, projecting beyond the third uropods, lobes diverging toward the tip, each armed distally with three or four spines.

Length, 9 mm.

Type locality.—Macon, Mississippi.

This species differs from the other members of the genus *Eucrangonyx* in the absence of the rudimentary inner ramus of the third uropods. In all other characters, however, it so closely resembles the species of this genus that it seems best to retain it in *Eucrangonyx* rather than to place it in a new genus.

EUCRANGONYX PACKARDII (Smith).

Crangonyx packardii SMITH, Mem. Nat. Acad. Sci., IV, 1888, pp. 34–36, pl. v, figs. 1–11.

The following description, with figures, is taken from Memoirs National Academy of Sciences, where the species is described by Prof. S. I. Smith as *Crangonyx packardii*.

This species is so closely allied to *Crangonyx gracilis* that it might readily be mistaken for it were it not for the peculiar structure of the eyes. The eyes of *C. gracilis* are composed of a few facets, and are abundantly supplied with black pigment. In all the specimens of *C. packardii* which I have seen the eyes are observable with difficulty, the black pigment being wholly wanting. The specimens received at first were very badly preserved, and I thought the absence of the pigment might be due to this fact; but subsequent examination of more perfect specimens shows that this can not be the case, and that the eyes are in life undoubtedly wholly without black pigment. The eyes are scarcely, if at all, observable in the ordinary alcoholic specimens, but when rendered translucent by immersion in glycerin the structure of the facets is distinctly observable, as shown in fig. 5. As observed by Doctor Packard, the flagella of the antennulæ of *C. gracilis* are a little shorter, and usually contain four or five segments less than *C. gracilis*, but this is an uncertain character, and some specimens of *C. gracilis* from Lake Superior actually have only one or more segments than the subterranean species. In the antennæ there are no constant differences. There are some very slight differences in the first and second pairs of legs; especially in the females, but not greater than usually exist in the individuals of a single species in allied genera, and any large series of specimens would undoubtedly show all the intermediate forms. In the third to the seventh pair of legs there is a constant difference in all the specimens examined, the spines being more numerous, longer, and more slender in *C. gracilis*. The spines upon the first and second caudal stylets are a little shorter and more obtuse in *C. packardii* than they usually are in *C. gracilis;* otherwise there is no difference in the caudal stylets and telson.

These differences are all such as very naturally lead to the supposition that this subterranean form has been derived from the *C. gracilis* at no very remote period,

although this supposition may well be held in reserve until we have a more complete series of the subterranean species for comparison. *C. gracilis* occurs as far south as Grand Rapids, Michigan, whence we have received specimens from Mr. N. Coleman, and it very likely occurs in the same region as *C. packardii*.

The figures are all from Professor Packard's original specimens, collected from wells in Orleans, Indiana, by Dr. Moses Elrod. Only one of these has the body entire; this is a female, 5.5 mm. long, and from which figs. 5 to 8 were made. A

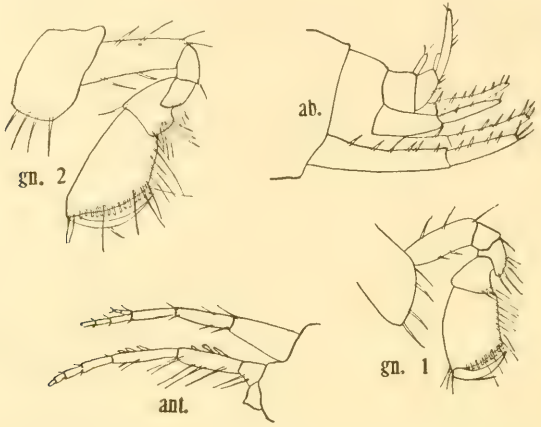


FIG. 5.—EUCRANGONYX PACKARDII. (After Smith.) *ab*, TERMINAL PORTION OF THE ABDOMEN WITH THE UROPODA.

large specimen, a female about 7.5 mm. long, unfortunately wanting most of the antennulæ and antennæ, collected from a well at New Albany, Indiana, by Dr. John Sloan, was sent to Doctor Packard for examination.

Genus NIPHARGUS W. P. Hay.

NIPHARGUS ANTENNATUS (Packard).

Crangonyx antennatus PACKARD, Am. Nat., XV, 1881, p. 880.
Eucrangonyx antennatus STEBBING, Trans. Linn. Soc. London, 2d ser., VII, 1899, p. 423.
Niphargus antennatus W. P. HAY, Proc. U. S. Nat. Mus., XXV, 1902, p. 429.

Eyes composed of a few slightly pigmented facets or wanting altogether, when present of no definite shape. First antennæ more than half as long as the body; first and second segments of the peduncle nearly equal in length, slightly longer than the third; flagellum about three times as long as the peduncle, composed of about twenty-five segments in the female; the number of segments in the flagellum varies in the two sexes according to Hay's description, there being more in the female than in the male; secondary flagellum longer than the basal segment of the primary one, composed of two segments, the distal one very short; each segment furnished distally with a few long hairs. Second antennæ not half so long as the first pair; flagellum short, not greatly exceeding the third segment of the peduncle and composed of about eight segments.

In the female the first gnathopods have the carpus short, triangular, as broad as the propodus; propodus less than twice as long as broad; anterior margin slightly convex; posterior margin straight or nearly so, furnished with a few fascicles of long hairs; palm slightly oblique and convex, furnished on each side with a few hairs, six or eight short notched spines, and one long stout spine at the tip of the closed dactyl; dactyl stout and curved. In the male, from Hay's description, the propodus is larger, stouter, and more strongly armed than in the female.

Propodus of the second gnathopods of the female elongated, twice as long as broad, narrowed distally; lateral margins slightly convex, the posterior one furnished with a few fascicles of long hairs; palm

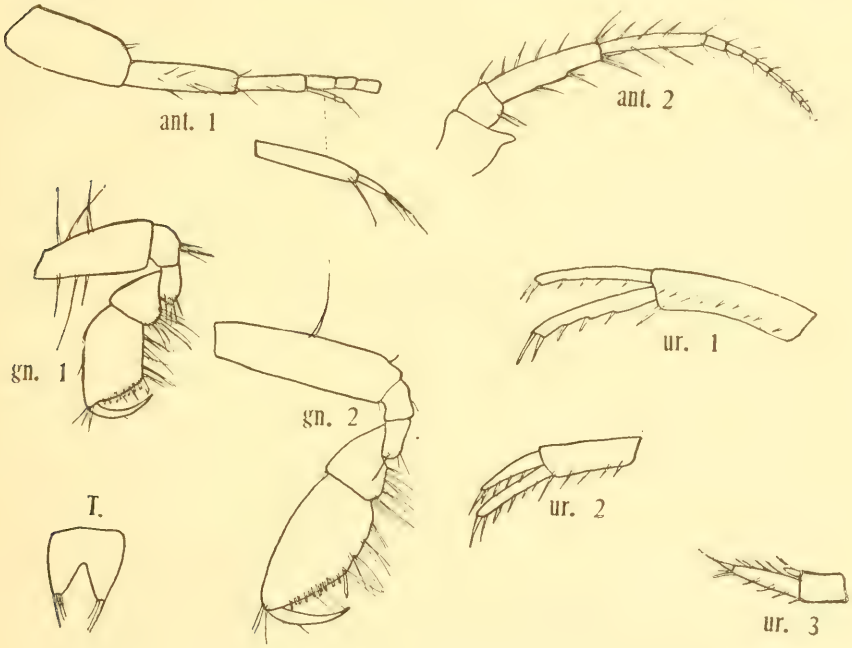


FIG. 6.—NIPHARGUS ANTENNATUS, FEMALE. NICKAJACK CAVE, SHELLMOUND, TENNESSEE.

oblique, convex, armed as in the first pair, but with more numerous spines. In the male, according to Hay's description, the second gnathopods are larger than in the female and have the propodus proportionally more developed.

The abdominal segments are rounded above and without spines.

The uropods project backward about an equal distance; the terminal pair are slightly longer than the peduncle of the second pair, with the outer ramus well developed, composed of two segments, the terminal one very short, and armed distally with a few spines, the first segment furnished on both margins with four or five spines; inner ramus short, rudimentary, and furnished with a few hairs at the tip.

Telson emarginate, the emargination reaching to the middle or nearly to the base; each lobe furnished at the truncate tip with three or four stout spines.

Length 10 mm.

This species has been collected at various places within Nickajack Cave, Shellmound, Tennessee.

The genus *Niphargus*, to which this species has been assigned by Hay, differs from *Crangonyx* in the telson, which in the latter genus is entire and in the former divided, and in the third uropods, which in *Crangonyx* are uniramous and in *Niphargus* biramous with the outer ramus biarticulate. It differs from *Eucrangonyx*, in which genus it has been placed by Stebbing, in the outer ramus of the third uropods, which in *Eucrangonyx* is uniarticulate and in *Niphargus* biarticulate.

Genus GAMMARUS Fabricius.

KEY TO SPECIES.

A. Telson cleft to the base.
  B. Eyes present.
    C. Third uropods with basal segment of outer ramus elongated, terminal segment short, styliform; inner ramus half or more than half as long as the outer; both rami furnished with long plumose hairs.
      D. Inner ramus of third uropods at least three-fourths as long as the outer; nearly as broad as the basal portion of the outer ramus.
        E. Terminal segment of outer ramus of third uropods with long plumose hairs on lateral margins; secondary flagellum composed of two to four segments ..... *G. limnæus*, p. 42
        EE. Terminal segment of outer ramus of third uropods without long plumose hairs on the lateral margins; secondary flagellum composed of five or six segments ..... *G. fasciatus*, p. 40
      DD. Inner ramus of third uropods only slightly more than half as long as outer ramus; much more slender than the basal portion of the outer ..... *G. propinquus*, p. 46
    CC. Third uropods with the basal segment of the outer ramus elongated, with fascicles of a few long hairs on lateral margins; terminal segment short; inner ramus rudimentary, shorter than the peduncle ... *G. ramellus*, p. 38
  BB. Eyes absent ..... *G. cæcus*, p. 47
AA. Telson not cleft to the base ..... *G. purpurascens*, p. 45

GAMMARUS RAMELLUS, new species.

Eyes small, reniform; their distance apart more than twice their diameter. First antennæ not quite half so long as the body; first and second segments of the peduncle about equal and nearly twice as long as the third; flagellum composed of twenty to twenty-five segments; secondary flagellum slightly exceeding the terminal segment of the peduncle in length and consisting of three or four segments. Second antennæ more than half as long as the first pair; peduncle longer than in the preceding pair; flagellum composed of eight to twelve segments.

First gnathopods of the male with the carpus triangular, as broad as long; propodus slightly longer than broad; lateral margins convex;

the posterior one furnished with three or four small fascicles of hairs; palm oblique, with two emarginations, and furnished with a few long hairs and a group of six or eight spines at the posterior angle; dactyl strongly curved, as long as the palm.

Carpus in the second gnathopods more elongated than in the first pair; propodus oblong; lateral margins only slightly curved, the posterior one furnished with six or seven fascicles of long hairs; palm less oblique than in the first pair, furnished with a row of long hairs at the base of the lamellar edge and six or seven spines at the rounded posterior angle; dactyl not so strongly curved as in the first pair, longer than the palm.

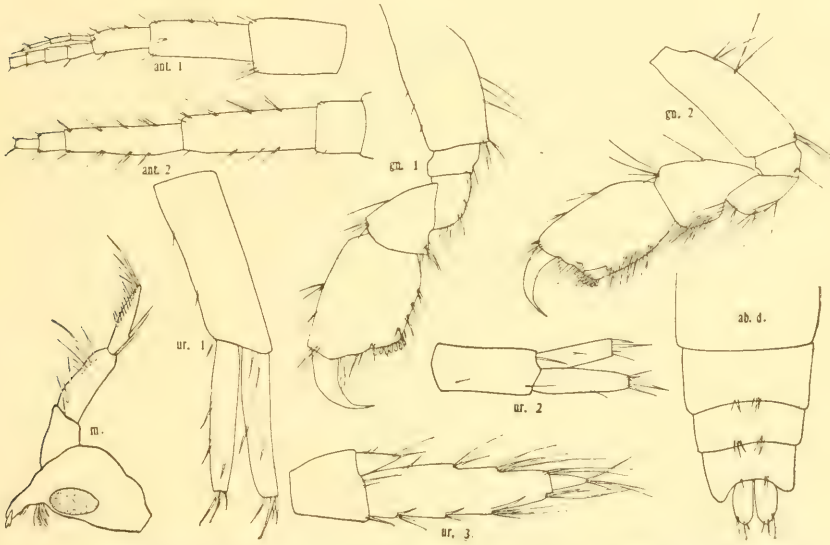


FIG. 7.—GAMMARUS RAMELLUS, MALE. POINT ARENA, CALIFORNIA. *m.*, MANDIBLE, DRAWN TO A LARGER SCALE THAN THE OTHER PARTS; *ab. d.*, DORSAL SIDE OF THE LAST SEGMENTS OF THE ABDOMEN.

Coxal plates of the last three peræopods with the posterior margins serrated and furnished with short spines.

Postero-lateral angles of the first three abdominal segments produced but little and terminating in a small spine. The last three or four abdominal segments are furnished dorsally on each side with a fascicle of two or three spines and a few short hairs.

First uropods projecting backward slightly beyond the peduncle of the third pair; third pair with the peduncle short, as broad as long, armed distally with a few hairs; outer ramus elongated, biarticulate, the basal segment long, tapering distally, armed laterally with fascicles of a few long hairs and one or two large spines; terminal segment very short, tapering distally and terminating in a tuft of long hairs; inner ramus rudimentary, slightly more than half as long as the

peduncle, furnished at the tip with a spine and a few hairs, and a few short hairs on the inner margin.

Telson cleft to the base, the lobes rounded distally and furnished with a few hairs and a few small spines.

Length, 10 mm.

Type locality.—Point Arena, California. Specimens from Portland, Oregon, were also examined. These were larger and stouter than those from California.

Type.—Cat. No. 32841, U.S.N.M.

GAMMARUS FASCIATUS Say.

Gammarus fasciatus Say, Jour. Acad. Nat. Sci. Phila., I, 1817, p. 374.—De Kay, Zool. of New York, VI, 1844, p. 37.—Bate, Cat. Amphipodous Crustacea British Mus., 1862, p. 210, pl. xxxvii, fig. 6.—Smith, Rep. U. S. Fish Com., 1872-73 (1874), p. 653.—Forbes, Bull. Ill. State Lab. Nat. Hist., No. 1, 1876, p. 6.

Eyes reniform; their distance apart slightly exceeding their diameter. First antennæ with the first and second segments nearly equal in length and twice as long as the third; flagellum twice as long as the peduncle and composed of about thirty segments; secondary flagellum as long as the second segment of the peduncle and consisting of five or six segments. Second antennæ about two-thirds the length of the first; peduncle exceeding that of the first pair, with the two distal segments elongated and nearly equal; flagellum slightly shorter than the peduncle and composed of about fifteen segments.

In the male the carpus of the first gnathopods is triangular, slightly longer than broad; propodus not quite twice as long as broad, much narrowed distally; palm slightly concave, very oblique, continuous with the posterior margin, with a narrow lamellar edge, armed with a few long hairs, near the middle of the inner side with a stout spine, at the base of which there is a fascicle of long hairs, and three or four smaller spines near the tips of the closed dactyl; posterior margin with four or five fascicles of long hairs; dactyl strongly curved and half as long as the propodus. Propodus of the female much smaller than that of the male, only slightly narrowed distally; palm not so oblique as in the male, furnished with a few long hairs and a few spines at the tip of the closed dactyl, but without a spine at the middle of the palm.

Propodus of the second gnathopods in the male as long as in the first pair, broadest distally; lateral margins nearly parallel; the posterior margin furnished with numerous fascicles of hairs; palm oblique, but not so much so as in the first pair, concave in the middle, armed with a few short hairs at the base of the broad lamellar edge, a stout median spine, and three or four smaller ones at the tip of the closed dactyl; dactyl not so strongly armed as in the first pair, as long as

the palm. Second gnathopods in the female much smaller than in the male; carpus elongated, as broad as the propodus; propodus narrow, twice as long as broad; lateral margins parallel; palm straight, transverse, without a lamellar edge and devoid of a median tooth.

Coxal plates of the last three peræopods with the posterior margin serrate.

The infero-posterior angles of the second and third abdominal segments are slightly produced, forming less than a right angle. The fourth, fifth, and sixth segments are slightly angulated dorsally, each

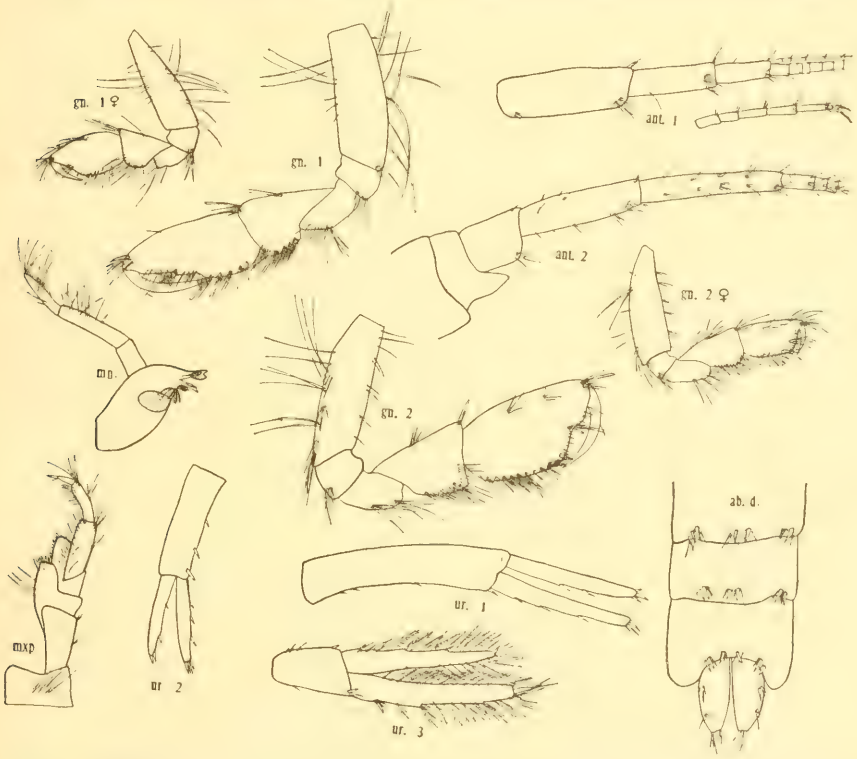


FIG. 8.—GAMMARUS FASCIATUS. *gn.* 1 ♀, *gn.* 2 ♀, FIRST AND SECOND GNATHOPODS OF A FEMALE, OTHER FIGURES FROM A MALE; *mn.*, MANDIBLE, AND *mxp.*, MAXILLIPED, DRAWN TO A LARGER SCALE THAN THE OTHER PARTS; *ab. d.*, DORSAL SIDE OF THE TERMINAL PART OF THE ABDOMEN.

bearing three fascicles of well-developed spines, the median one of which on the fourth and fifth segments is raised on a distinct protuberance.

First uropods exceeding the second pair in length and projecting backward slightly beyond the peduncle of the terminal pair; outer ramus of the terminal pair composed of two segments, the first segment elongated, furnished on both margins with many long plumose hairs and on the outer margin with several small obtuse spines; the distal segment very short, styliform, and furnished at the tip with several hairs, but having no hairs on the lateral margins; inner ramus

not quite so long as the first segment of the outer ramus, armed with a few spines on the inner margin and numerous long plumose hairs on both margins.

Telson cleft to the base, the lobes furnished distally with two or three spines and a few hairs.

Length, 10–15 mm.

Distribution.—Hudson River and Niagara Falls, New York; Ann Arbor, Michigan; Lake Superior; Delavan and Lake Geneva, Wisconsin; Havana, Illinois; Burlington, Iowa; Redfoot Lake, Tennessee; Brookside, West Virginia; Washington, District of Columbia; St. Johns River, Florida.

GAMMARUS LIMNÆUS Smith.

Gammarus lacustris Smith, Amer. Jour. Sci., 3d ser., II, 1871, p. 453; Prel. Rept. on Dredgings in Lake Superior, 1871, p. 1023.

Gammarus limnæus Smith, 7th Rept. U. S. Geol. Survey, 1874, p. 609; Rept. U. S. Fish Com., 1872–73, p. 651, 1874.

Gammarus robustus Smith, 7th Rept. U. S. Geol. Survey, 1875, p. 610.

Eyes small, slightly elongated. First antennæ about as long as the thorax; first and second segments of the peduncle nearly equal, twice as long as the third; flagellum composed of about thirty elongated segments, which are furnished with few hairs; secondary flagellum composed of two to four segments, of which the terminal one is short. Second antennæ slightly shorter than the first; peduncle exceeding that of the first pair with the two distal segments nearly equal in length; flagellum shorter than or nearly equal to the peduncle, consisting of about twelve segments.

First gnathopods of the male with the carpus broadly triangular, as broad as the propodus; propodus a little less than twice as long as broad, much narrowed distally; palm very oblique, continuous with the posterior margin, and having a lamellar edge furnished with a few long hairs, and two long obtuse spines near the middle, and three or four smaller spines on each side near the posterior angle; dactyl strongly curved and about one-half as long as the propodus; lateral margins convex, the posterior one furnished with a few long hairs and several short, obtuse spines. In the female the propodus is considerably smaller and proportionally shorter than in the male; palm oblique, with a narrow lamellar edge continuous with the posterior margin, furnished with a few long hairs, and several spines on each side of the tip of the closed dactyl; posterior margin furnished with several short spines, and numerous long hairs arranged in several fascicles.

Carpus of the second gnathopods in the male slightly longer than in the first pair; propodus as long as in the first pair, slightly broadest distally; lateral margins nearly parallel, posterior one furnished with five or six fascicles of long hairs; palm slightly oblique, concave at the

middle, with a broader lamellar edge than in the first pair; armed with a long, obtuse spine and a fascicle of long hairs at the center, two or three small spines at the posterior angle, and a row of short hairs at the base of the lamellar edge. In the female the carpus and propodus are much smaller than in the male and proportionally more elongated; carpus fully as broad as the propodus; propodus twice as long as broad, palm straight, nearly transverse, without the median spine.

Posterior margin of the coxal plates of the last three peræopods serrate.

Fourth and fifth abdominal segments rounded above, each bearing three fascicles of small spines; the sixth segment with two lateral

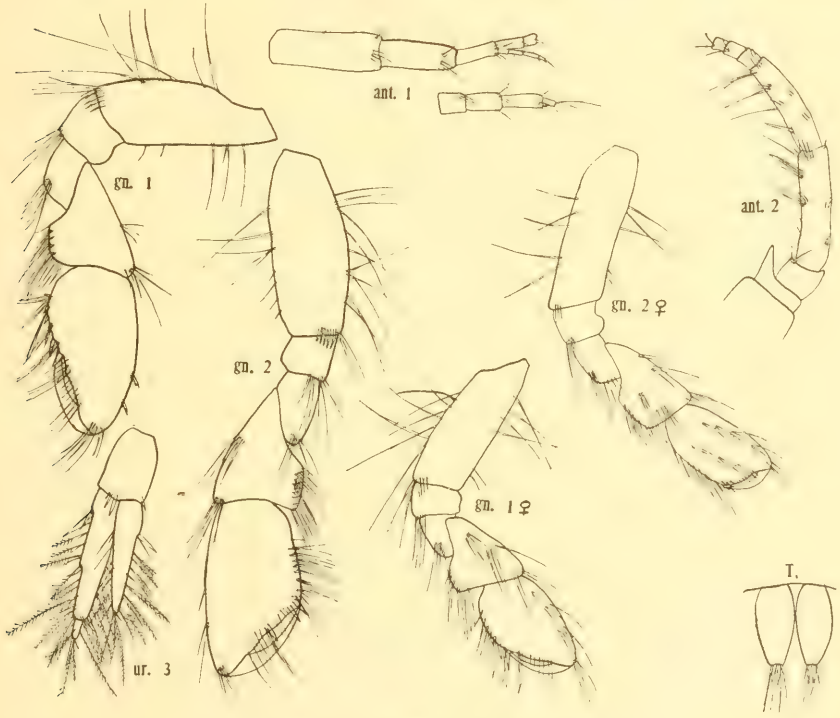


FIG. 9.—GAMMARUS LIMNÆUS. ANN ARBOR, MICHIGAN.

fascicles and two or three short median hairs. Infero-posterior angle of the first abdominal segment rounded, in the second and third produced posteriorly and forming an acute angle.

First pair of uropods exceeding the second pair in length and extending slightly beyond the peduncle of the third pair. Outer ramus of the terminal pair narrow, the basal segment furnished on both margins with many long plumose hairs, and on the outer margin with a few short spines; terminal segment short, styliform, lateral margins as well as tip furnished with long plumose hairs; inner ramus slightly shorter than the basal portion of the outer, with both

margins furnished with long plumose hairs and the inner with a few spines.

Telson cleft to the base, each division furnished with three or four short spines and several long hairs.

Length, 15 mm.

Aroostook County, Maine; Caledonia, New York; Marquette, Ann Arbor, and Isle Royal, Michigan; dredged in Lake Superior; Fort Wingate, New Mexico; Wahsatch Mountains; Shoshone Falls, Idaho; Salt Lake City, Utah; Flat Head Lake, Montana; Yellowstone National Park.

This species closely resembles *Gammarus fasciatus*, from which it can be distinguished most easily by the presence of long plumose hairs on the lateral margins of the terminal segment of the outer ramus of the third uropods. The other characters in which these two species differ can be appreciated only by a careful comparison of specimens of the two species. The antennæ in *Gammarus limnæus* are furnished with fewer hairs than in *Gammarus fasciatus* and the secondary flagellum consists of two to four segments (in *Gammarus fasciatus* five or six). The propodus of the first gnathopods of the male of *Gammarus limnæus* is broader at the proximal end than in *Gammarus fasciatus*; the lateral margins are more convex, and the posterior margin is furnished with spines, which, if present in *Gammarus fasciatus*, are very small. In the female the propodus of the first gnathopods of *Gammarus limnæus* is much narrower distally and the palm is more oblique than in the other species. In *Gammarus limnæus* the spines on the abdominal segments are smaller and the median ones are not raised on distinct protuberances as they are in *Gammarus fasciatus*.

After a careful comparison of the description and figures of *Gammarus limnæus* Smith and *Gammarus robustus* Smith I have concluded that they are the same species. The two species correspond in all characters except the gnathopods, and the differences which are there pointed out are not sufficiently marked to justify distinguishing the two forms as separate species. In *Gammarus limnæus* the propodus of the first gnathopods is longer in proportion to the width, the palm is more oblique, and the posterior margin is armed with more spines than in *Gammarus robustus*. In the second gnathopods the propodus of *Gammarus limnæus* is longer than in *Gammarus robustus*. These are differences which appear in specimens of different sizes. From the lengths of the two species which Smith gives (*Gammarus limnæus* 15–20 mm. and *Gammarus robustus* 10–15 mm.) he evidently examined larger specimens of *Gammarus limnæus* than of *Gammarus robustus*, which fact would account for the differences in the gnathopods which he found.

GAMMARUS PURPURASCENS W. P. Hay.

Gammarus purpurascens W. P. HAY, Proc. U. S. Nat. Mus., XXV, 1902, p. 433.

Eyes large, reniform; larger than in *Gammarus limnæus* Smith, which species *Gammarus purpurascens* resembles. First antennæ longer than in *Gammarus limnæus*, about half the length of the body; first and second segments of the peduncle nearly equal in length; third segment about half as long as the second; flagellum composed of twenty-five to thirty segments; secondary flagellum consisting of four

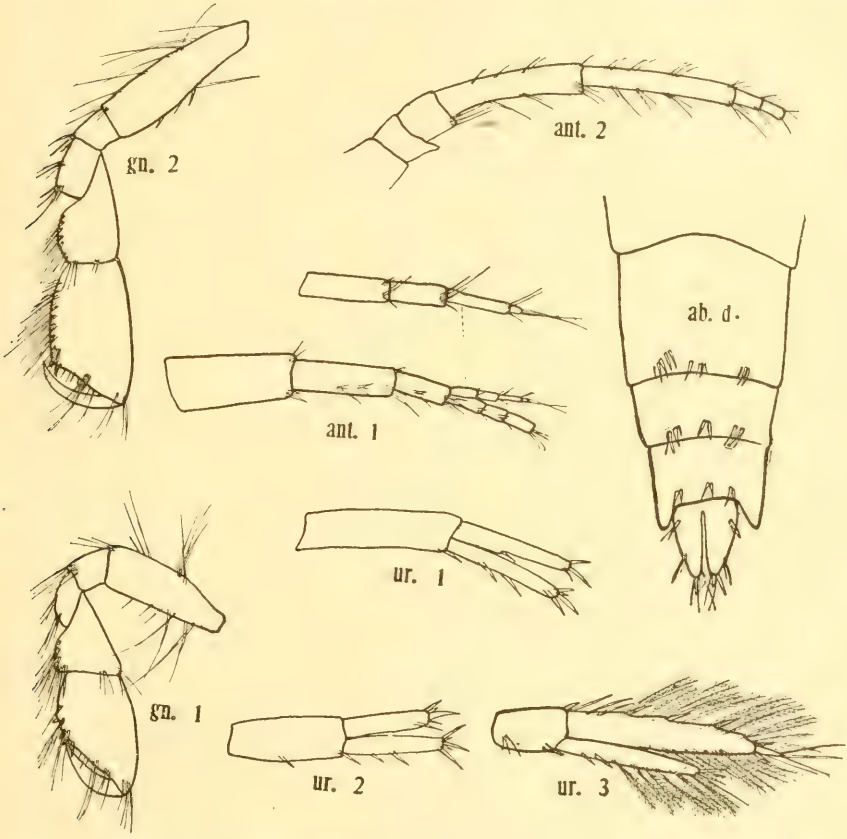


FIG. 10.—GAMMARUS PURPURASCENS, MALE. NICKAJACK CAVE. *ab. d.*, DORSAL SIDE OF THE TERMINAL SEGMENTS OF THE ABDOMEN.

segments, the distal one very short and tapering. Second antennæ slightly more than half as long as the first pair; peduncle exceeding that of the first pair in length, the two distal segments elongated, nearly equal; flagellum slightly shorter than the peduncle, composed of about ten segments, each of which bears a small olfactory club.

First gnathopods of the male with the carpus broadly triangular, nearly as broad as the propodus; propodus broad, narrowed distally;

palm very oblique, continuous with the posterior margin and furnished with a few short hairs on each side, a fascicle of long ones at the center, and a few spines at the tip of the closed dactyl; the posterior and anterior margins of the propodus convex, the posterior one provided with a few fascicles of long hairs and one or two small spines near the palm; dactyl strongly curved, half as long as the propodus.

Second gnathopods with the propodus rectangular, more than half as broad as long; lateral margins only slightly convex, the posterior with about eight fascicles of long hairs; palm oblique, furnished as in the first pair except that no spines extend upon the posterior margin; dactyl not so strongly curved as in the first pair, extending slightly beyond the palm.

Basal plates of the third, fourth, and fifth peræopods narrow, broadest proximally, with margins serrate and furnished with a few spines.

Three posterior segments of the abdomen rounded dorsally, each furnished with three small fascicles of spines; the spines of the median fascicles smaller than those of the lateral ones.

First pair of uropods slightly exceeding the second pair in length, projecting somewhat beyond the peduncle of the third; third pair with a short peduncle only slightly longer than broad; the outer ramus consisting of two segments, the basal one long and narrow with four or five spines on the outer margin and many long plumose hairs; terminal segment very short, styliform, and furnished distally with a few long hairs; inner ramus about three-fourths as long as the basal portion of the outer, with many long plumose hairs and usually a few spines on the inner margin. Telson divided almost to the base, with a spine and a few hairs on the outer margin, and three or four spines and a few short hairs distally.

Length, 10 mm.

The type specimens of this species were collected at the mouth of Nickajack Cave, Shellmound, Tennessee. Specimens of a smaller size have also been found in a spring at Rossville, Georgia.

GAMMARUS PROPINQUUS W. P. Hay.

Gammarus propinquus W. P. Hay, Proc. U. S. Nat. Mus., XXV, 1902, p. 224.

This species is very similar to *Gammarus fasciatus* Say, but differs from it in the following characters: The secondary flagellum consists of from two to five segments; in *Gammarus fasciatus* from five to six. The palm of the first gnathopods of the male in *G. fasciatus* is more irregular and more concave. In the second gnathopods it is more concave and slightly more oblique than in *Gammarus propinquus*. The best distinguishing characteristic, however, is in the third uropods, the inner ramus of which in *Gammarus propinquus* is much more slender than the outer and half or only slightly more than half as long.

In *Gammarus fasciatus* the inner ramus is only slightly narrower than the outer and at least three-fourths as long.

Length, 10–15 mm.

Specimens of this species have been collected in several localities in regions about Mammoth Cave, Kentucky, the type coming from a

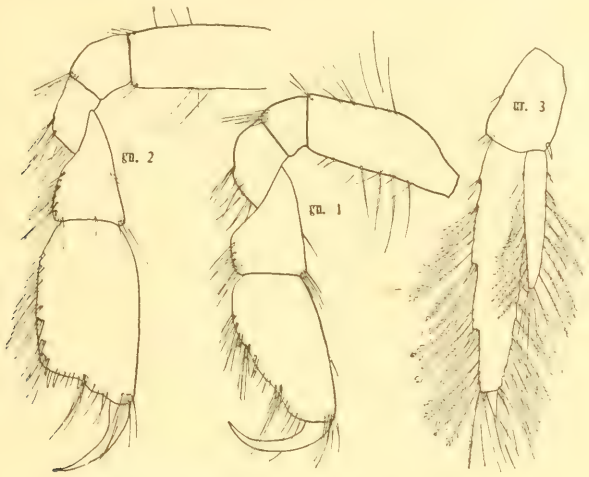


FIG. 11.—GAMMARUS PROPINQUUS, MALE. MAMMOTH CAVE, KENTUCKY.

spring about 2 miles north of this cave; collected also in springs in the Ozark Mountains, Missouri, and in West Virginia.

GAMMARUS CÆCUS, new species.

Eyes absent. First antennæ more than half as long as the body; second segment of the peduncle slightly longer than the first and about three times as long as the third; flagellum composed of twenty to thirty elongated segments, each bearing a few short hairs at the distal end; secondary flagellum reaching slightly beyond the third segment of the primary flagellum, composed of four segments, the distal one short and furnished with long hairs.

Second antennæ are about two-thirds as long as the first pair with the peduncle extending far beyond that of the first pair; ultimate segment of the peduncle only slightly longer than penultimate which is greatly elongated and about equal in length to the antepenultimate; flagellum composed of about twelve segments, which are shorter than those of the first antennæ and furnished with more hairs.

The carpus of the first gnathopods of the male is triangular and elongated with the anterior margin furnished with a few long hairs and numerous short ones; propodus narrower than the carpus, twice as long as broad, with the anterior margin concave, armed sometimes with a fascicle of hairs, the posterior margin convex, and the palm

almost straight, slightly convex, and armed with four or five spines and a few short hairs; dactyl as long as the palm and fitting it closely.

Second gnathopods with a carpus broader than in the first pair but similarly armed; propodus not so broad as the carpus, about twice as long as broad and larger than in the first gnathopods; posterior margin almost straight; anterior margin slightly convex and usually furnished with one or two fascicles of hairs; palm very oblique, slightly concave at the center, armed with five or six spines at the tip of the closed dactyl, and one or two spines and a few short hairs on the margin; dactyl strongly curved, as long as the palm.

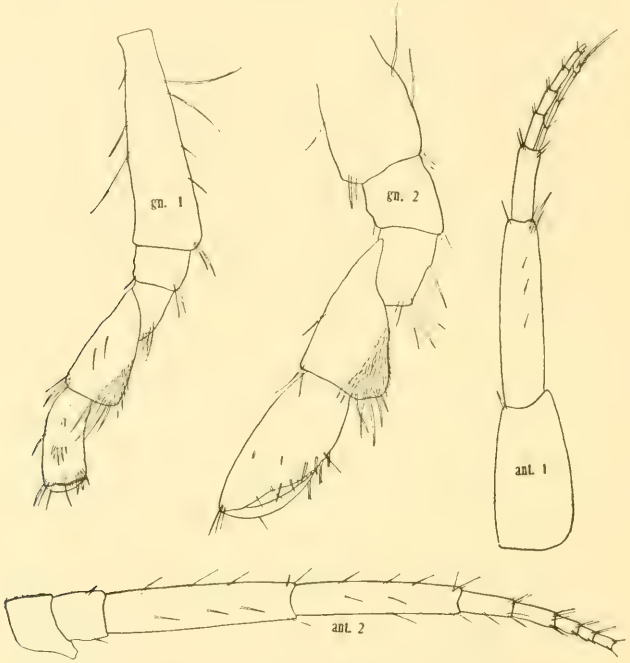


FIG. 12.—GAMMARUS CÆCUS, MALE. MODESTA CAVE, NEAR CAÑAS, CUBA.

Both margins of the coxal plates of the third, fourth, and fifth peræopods are serrate and furnished with spines, those on the anterior margin being smaller than those on the posterior.

Postero-lateral angles of the third and fourth abdominal segments are produced backward and end in a blunt tooth. The last two or three abdominal segments are furnished dorsally with a few short spines.

The first uropods project slightly beyond the second pair. In both pairs the rami are about equal in length and slightly longer than the peduncle. The third uropods were broken off in the few specimens which I had for examination. Telson cleft to the base, armed distally with a few short spines.

Length, 10 mm.

Collected by Dr. C. H. Eigenmann among the roots of a tree, Modesta Cave, near Cañas, Cuba.

Type.—Cat. No. 32689, U.S.N.M.

Genus CRANGONYX Bate.

KEY TO SPECIES.

A. Telson nearly as broad as long, with a slight emargination distally; second uropods with rami equal ..... *C. vitreus*, p. 49.

A A. Telson entire, two-thirds as broad as long; rami of second uropods unequal, the outer ramus about half as long as the inner ..... *C. tenuis*, p. 50.

CRANGONYX VITREUS (Cope).

Stygobromus vitreus Cope, Amer. Nat., VI, 1872, p. 422; 3rd and 4th Annual Repts. of Geol. Survey of Indiana, 1872, p. 181.

Crangonyx vitreus Packard, 5th Annual Rept. Peabody Academy of Science, Salem, 1873, p. 95.—Smith, Rept. U. S. Fish Com., 1872–73 (1874), p. 656; Amer. Jour. Sci., 3rd series, IX, 1875, p. 476.

Blind. First antennæ more than half as long as the body; the three segments of the peduncle nearly equal in length; flagellum composed of about fifteen segments; secondary flagellum reaching beyond the first segment of the primary one, consisting of two segments. Second antennæ slightly less than half as long as the first pair; peduncle extending beyond that of the first pair with the two distal segments elongated and nearly equal; flagellum very short, scarcely exceeding the distal segment of the peduncle in length and composed of six segments.

Propodus of the first gnathopods in the male slightly longer than broad; lateral margins convex, the posterior margin furnished with a few long hairs arranged in four or five fascicles; palm oblique, convex, armed with four or five groups of long hairs and nine or ten notched spines, one of which at the posterior angle is much longer than the other; dactyl stout. In the second gnathopods the propodus is more elongated and more narrowed distally than in the first pair; palm very oblique, convex, armed as in the first pair but bearing a few more spines.

Both margins of the coxal plates of the last three pairs of peræopods are serrate and armed with small spines.

First and second uropods extending beyond the telson; the third pair projecting only about half way to the tip of the telson; peduncle about as broad as long; the single ramus very small, about one-third as long as the peduncle, slightly longer than broad, and furnished distally with two short hairs. Telson nearly as broad as long, a very slight triangular emargination at the broad distal end, on either side of which are four or five spines.

Length, 5 mm.

Specimens from Mammoth Cave, Kentucky, and Orleans, Indiana.

In this species the telson has a slight emargination, a feature which does not accord with the definition of this genus. The other characters of the species, however, are so much like those of the recognized members of the genus *Crangonyx* that it seems best not to assign it to a new genus. The specimens upon which this description is based were sent to me from the United States National Museum under the name *Crangonyx vitreus* Packard. The specimens agree in the main with Packard's description of this species; however, he has described

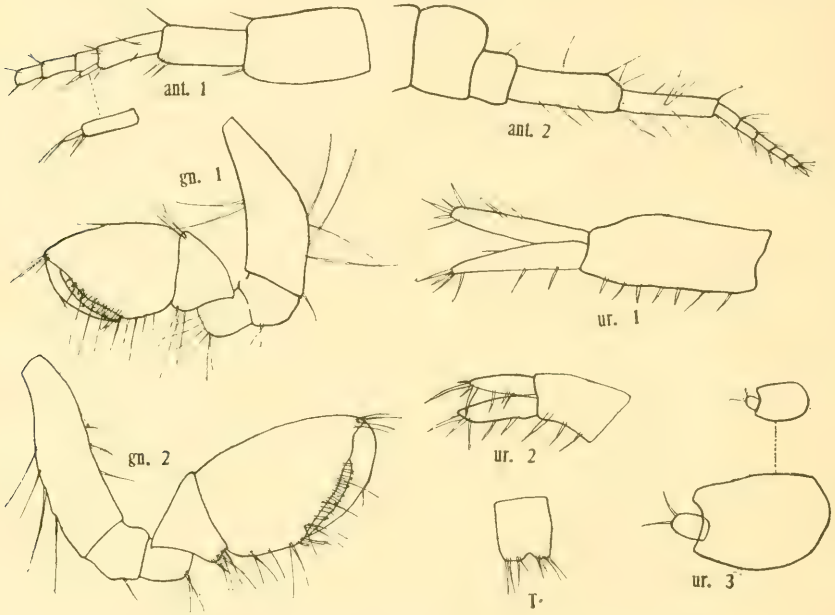


FIG. 13.—CRANGONYX VITREUS, MALE. MAMMOTH CAVE, KENTUCKY.

his specimens so imperfectly that I can not be certain that the specimens which I have described as *C. vitreus* belong to the same species as Packard's. I have followed Packard in quoting *Stygobromus vitreus* Cope, as a synonym of *Crangonyx vitreus* but from Cope's very short description of his specimens it is very doubtful if they belong to the same species or even genus as Packard's *Crangonyx vitreus*.

CRANGONYX TENUIS Smith.

Crangonyx tenuis SMITH, Rept. U. S. Fish Com., 1872–73 (1874), p. 656.

I have had no specimens of this species for examination, but quote the original description:

A slender, elongated species, with very low epimera, resembling more in form the species of *Niphargus* than the typical species of *Crangonyx*.

Eyes not observable in alcoholic specimens. Secondary flagellum of the antennulæ very small, composed of two segments, of which the terminal is very short.

First and second pairs of legs differing but little in the two sexes. First pair stouter than the second, and with the palmary margin of the propodus much more oblique; the palmary margin of the propodus of both pairs, and in both sexes, armed on each side with a series of stout, obtuse spines, with a notch and a cilium near the tip.

First three segments of the abdomen longer than the last three of the thorax; fourth, fifth, and sixth together scarcely longer than the third. Caudal stylets all extending to about the same point. First pair with the rami subequal, scarcely half as long as the peduncle. Peduncle in the second pair reaching a little beyond the peduncle of the first pair; the rami very unequal, the outer only half as long as the inner. Posterior pair scarcely as long as the telson; the single terminal segment very small, and tipped with four or five setiform spinules. Telson two-thirds as broad as long, tapering very slightly toward the entire and slightly arcuate posterior margin, which is armed with about ten slender spinules.

In the largest male seen, 13.5 mm. in length (excluding the antennæ), the antennulæ are about 5 mm. long, the flagellum being twice as long as the peduncle and composed of about twenty-two segments, while the antennæ are stout, fully 6 mm. long, and the flagellum as long as the peduncle, and composed of fifteen segments. All the females and most of the males which I have seen are much smaller, being 6 mm. to 8 mm. in length, and in these the antennulæ are longer than the antennæ; and the flagellum of the antennulæ is composed of sixteen to nineteen segments, while that of the antennæ has only eight to ten.

The only specimens which I have seen were found in wells at Middletown, Conn., and were sent to me by Mr. G. Brown Goode.

Genus STYGONECTES W. P. Hay.

STYGONECTES FLAGELLATUS (Benedict).

Crangonyx flagellatus Benedict, Proc. U. S. Nat. Mus., XVIII, 1896, p. 616.
Crangonyx bowersii Ulrich, Trans. Amer. Microscopical Soc., XXIII, 1902, p. 85, pl. xiv.
Stygonectes flagellatus W. P. Hay, Proc. U. S. Nat. Mus., XXV, 1902, p. 429.

This blind species is closely related to *Eucrangonyx mucronatus* (Forbes). It is, however, larger and much stouter. The head, which is slightly longer than the first thoracic segment, is proportionally narrower and more concave at the insertion of the upper antennæ than in *Eucrangonyx mucronatus*.

First antennæ as long as the body; first two segments of the peduncle about equal and three times as long as the third; flagellum composed of forty to sixty segments; secondary flagellum extending slightly beyond the basal segment of the primary one, composed of two segments, the first about four times the length of the second. Second antennæ slightly less than half as long as the first pair; peduncle exceeding that of the first pair in length; two distal segments much elongated and nearly equal; flagellum not quite so long as the peduncle, composed of twelve to eighteen segments.

Propodus of the first gnathopods in the male about two-thirds as broad as long; lateral margins only slightly convex, the posterior

margin furnished with three or four fascicles of spines; palm very oblique, slightly convex, with a narrow lamellar edge furnished on each side with a row of about twenty-four bifurcate spines, two or three of which extend upon the posterior margin; dactyl stout and strongly curved.

In the second gnathopods of the male the propodus is about equal in size to that of the first pair, but with the palm less oblique and the posterior margin correspondingly longer.

First uropods extend to the tips of the second pair, the peduncle slightly longer than the two rami; second uropods about two-thirds

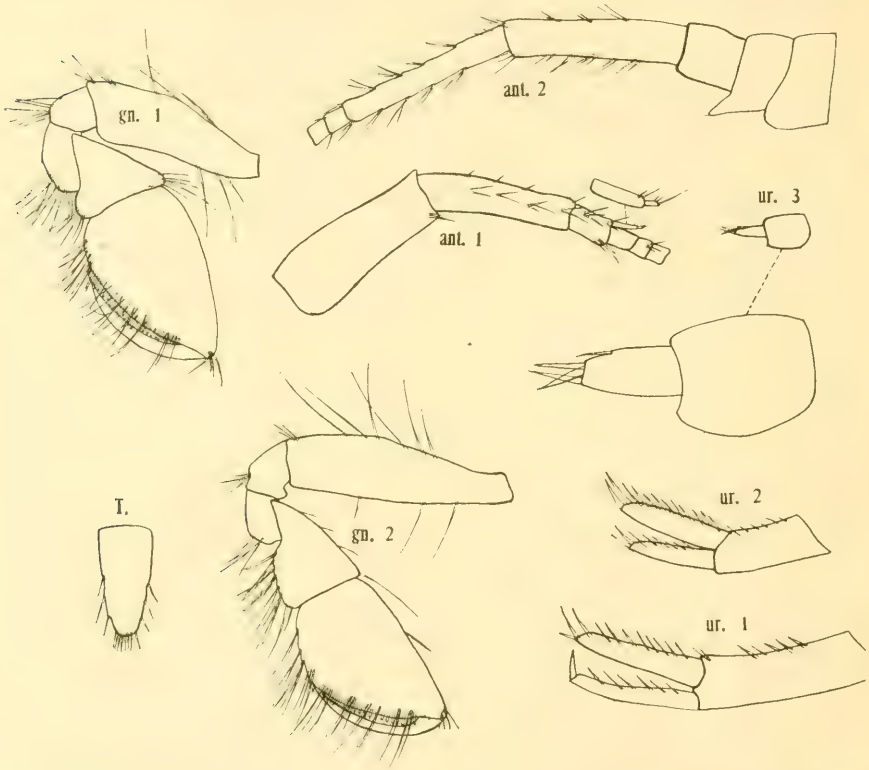


FIG. 14.—STYGONECTES FLAGELLATUS, MALE. SAN MARCOS, TEXAS. THE RUDIMENTARY INNER RAMUS OF THE THIRD UROPOD WAS BROKEN IN THE SPECIMEN DRAWN.

as long as the first ones; the first and second pairs reaching far beyond the third pair (in *Eucrangonyx mucronatus* they extend only slightly beyond the tip of the third pair); terminal uropods very small, about two-thirds as long as the peduncle of the second pair; inner ramus rudimentary; the outer one about as long as the peduncle and furnished distally with a few spines. Telson entire, about three times as long as broad at the base, tapering slightly to the distal end, which is subtruncate; furnished with several spines at the tip and four or five spines on the lateral margins.

Length, 13 mm.

Specimens examined from an artesian well San Marcos, Texas, the type locality.

Crangonyx bowersii Ulrich is undoubtedly the same species as *Stygonectes flagellatus*. The specific differences which Ulrich points out, together with the rather small size of the single specimen which he examined, indicate that he had an immature specimen. The only differences which he gives are in the number of segments in the antennæ and the number of spines on the propodus, which in *Crangonyx bowersii* are less than in *Stygonectes flagellatus*. These are characters which vary with age, there being fewer segments in the antennæ and fewer spines on the propodus in the immature forms.

This is the type species of the genus *Stygonectes* to which it was assigned by Prof. W. P. Hay. This genus closely resembles the genus *Crangonyx*, but differs from it in having the last two segments of the urosome coalescent.

Genus APOCRANGONYX Stebbing.

APOCRANGONYX LUCIFUGUS (O. P. Hay).

Crangonyx lucifugus O. P. Hay, Am. Nat., XVI, 1882, p. 144.
Apocrangonyx lucifugus Stebbing, Trans. Linn. Soc. London, 2d ser., VII, 1899, p. 422.

This species is the type species of the genus *Apocrangonyx* to which it has been assigned by Stebbing. This genus differs from *Crangonyx*, in which the species was placed by Hay, in the rudimentary third uropods which are without rami.

I have had no specimens of this species for examination, but quote the original description:

This is a small, rather elongated species that was obtained from a well in Abingdon, Knox County, Illinois. As befits its subterranean mode of life, it is blind and of a pale color. In length the largest specimens measure about 6 mm.

Male.—Antennulæ scarcely one-half as long as the body. The third segment of the peduncle two-thirds as long as the second; this two-thirds the length of the first. Flagellum consisting of about fourteen segments. The secondary flagellum very short and with but two segments. Antennæ short, only half as long as the antennulæ. Last two segments of its peduncle elongated. Flagellum consisting of but about five segments, and shorter than the last two segments of the peduncle taken together.

Second pair of legs stouter than the first. Propodite of first pair quadrate, with nearly a right angle between the palmar and posterior margins. Palmar margin on each side of the cutting edge, with a row of about six notched and ciliated spines, one or two of which at the posterior angle are larger than the others. The cutting edge is entire. Dactylopodite as long as the palmar margin, and furnished along the concave edge with a few hairs.

Propodite of the second pair of legs ovate in outline, twice as long as broad. The palmar margin curving gradually into the posterior margin. The cutting edge of the palmar surface uneven, and having near the insertion of the dactyl a square projection. The palmar surface also armed with two rows of notched and ciliated spines, five in the inner row, seven in the outer. Dactyl stout and short.

Two posterior pairs of thoracic legs longest of all and about equal to each other. All the legs are stout and their basal segments squamiform.

Postero-lateral angle of first abdominal segment rounded, of second and third from obtuse angled to right angled.

First pair of caudal stylets extending a little farther back than the second; these exceeding slightly the third. The peduncle of the first pair somewhat curved, with the concavity above, the rami equal and two-thirds as long as the peduncle. The peduncle of the second pair little longer than the outer ramus. Inner ramus nearly twice as long as the outer. Third pair of caudal stylets rudimentary, consisting of but a single segment. This somewhat longer than the telson, broadly ovate, two-thirds as broad as long and furnished at the tip with two short spines.

Telson a little longer than wide, narrowing a little to the truncated tip, which is provided at each postero-lateral angle with a couple of stout spines.

Female.—In the female the propodite of the anterior pair of feet resembles closely that of the corresponding foot of the male. The palmar margin of the second propodite is less oblique than in the second foot of the male and does not pass so gradually into the posterior margin. It is also destitute of the jagged edge and the square process of the male foot. There are fewer spines along the margin. One of the spines at the posterior angle is very long and stout.

This species appears to resemble *C. tenuis* Smith, but is evidently different. In that species, as described by Prof. S. I. Smith, the first pair of feet are stouter than the second and have the palmar margin of the propodite much more oblique. The reverse is true of the species I describe. Nor do I understand from the description of *C. tenuis* that the posterior caudal stylets each consist of a single segment. There are some minor differences. From *C. citreus*, judging from Professor Cope's description in *American Naturalist, Vol. 6, p. 422*, it must differ in the caudal stylets. "Penultimate segment, with a stout limb with two equal styles," is a statement which will not apply to my species, whichever the "*penultimate*" segment may be.

Family ORCHESTIIDÆ.

Genus HYALELLA Smith.

HYALELLA KNICKERBOCKERI (Bate).

Allorchestes knickerbockeri Bate, Cat. Amphip. Crust. Brit. Mus., 1862, p. 36, pl. vi.

Hyalella dentata Smith, Rep. U. S. Fish Com., 1872–73 (1874), p. 645, pl. ii.

Hyalella inermis Smith, 7th Rept. U. S. Geol. Survey of Colorado, 1873 (1875), p. 610.

Allorchestes dentatus Faxon, Bull. Mus. Comp. Zool., III, 1876, p. 373, figs. 35, 36.

Allorchestes dentatus var. *inermis* Faxon, Bull. Mus. Comp. Zool., III, 1876, p. 373.

Hyalella inermis Stebbing, Proc. U. S. Nat. Mus., XXVI, 1903, p. 929.

Hyalella faxoni Stebbing, Proc. U. S. Nat. Mus., XXVI, 1903, p. 928, pl. lxi.

Eyes round or nearly so; their distance apart slightly greater than their diameter. First antennæ shorter than the second pair; first and second segments of the peduncle about equal in length, slightly longer than the third; flagellum about twice as long as the peduncle and composed of seven to nine segments; second antennæ about half as long as the body; peduncle exceeding that of the first pair with the two distal segments elongated and nearly equal; flagellum usually but little longer than that of the first pair and composed of eight to fifteen segments.

First gnathopods in the male more than half as broad as long; lateral margins strongly curved and furnished with minute spinules; palm transverse, concave at the middle, provided with a few small teeth and short hairs at the posterior angle and a tuft of long stiff hairs at the anterior one; dactyl strongly curved, shorter than the palm. First gnathopods in the female closely resemble those in the male.

Second gnathopods of the male much longer than the first ones; carpus not longer than broad, with a long narrow lobe extending along the posterior margin of the propodus; propodus stout, more than half as broad as long, much broadened distally, especially in the mature

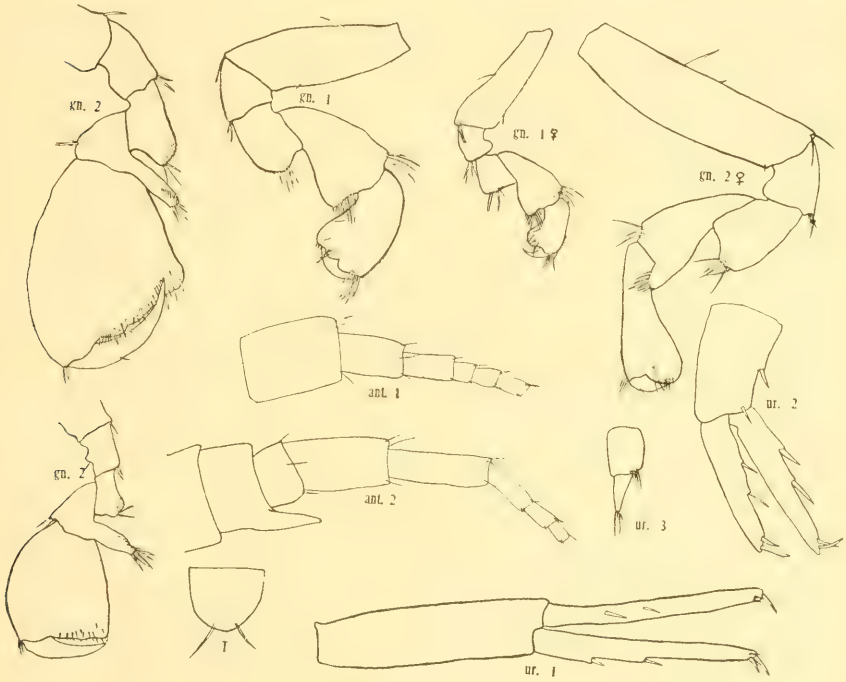


FIG. 15.—HYALELLA KNICKERBOCKERI. ANN ARBOR, MICHIGAN. *gn.* 1♀, *gn.* 2♀, FIRST AND SECOND GNATHOPODS OF THE FEMALE; OTHER FIGURES OF THE MALE. *gn.* 2′, SECOND GNATHOPOD OF A YOUNG MALE; *gn.* 2, SECOND GNATHOPOD OF A MATURE MALE.

specimens; anterior margin convex; posterior one straight, oblique, and unarmed; palm oblique, the middle portion slightly arcuate, with a notch near the middle and one or two slight emarginations at the posterior angle; provided with a submarginal row of spines; palm in immature specimens transverse, emarginations very slight, dactyl not so strongly curved as in the adult. Second gnathopods of the female slender and weak; carpus and propodus elongated and much narrower than those of the male; carpus more than twice as long as broad, posterior projection proportionally not so great as in the male; propodus more than twice as long as broad; palm forming less than a right

angle with the posterior margin, furnished with fewer submarginal spines than in the male; dactyl not strongly curved and fitting the palm closely.

Posterior margins of the coxal plates of the third, fourth, and fifth peræopods serrate.

Postero-lateral angles of the first two abdominal segments slightly produced, forming less than a right angle; the first two or three segments usually produced dorsally, forming a well-marked median posterior tooth.

First uropods almost twice as long as the second pair; third pair very short, not exceeding the basal segment of the second pair in length; peduncle short, nearly as broad as long, furnished distally with a few hairs; the single ramus slender, tapering, about equal in length to the peduncle and provided with a few slender setæ at the tip.

Telson short, entire, as broad as long, and furnished distally with a slender seta at each side. Length not exceeding 7 mm.

Abundant throughout the United States. Collected at Caribou, Maine; Cambridge and Quisset Pond, Massachusetts; Ann Arbor, Michigan; Isle Royal, Lake Superior; Wisconsin River, Lake Geneva, Lake Delavan, and Winnebago Lake, Wisconsin; Omaha, Nebraska; Urbana, Pekin, Clifton, Havana, McHenry County, Meredosia Lake, and Lake Michigan, at South Chicago, Illinois; New Philadelphia and Tuscarawas River, Ohio; Piney Branch, District of Columbia; Point Pinellas, Florida; San Marcos, Texas; Lake Merced, Fresno, Los Angeles, West Berkeley, and San Francisco, California; Yellowstone National Park; Volcan Reventado, Costa Rica.

Through the kindness of Dr. S. J. Holmes, who has compared the types of Bate's *Allorchestes knickerbockeri* in the British Museum with specimens of *Hyalella dentata* Smith, I am enabled to state definitely that the latter are of the same species as Bate's types. From Bate's description of *Allorchestes knickerbockeri* in the Catalogue of Amphipodous Crustacea in the British Museum, one can not establish this identity, for some of Bate's statements in this description do not agree with his own specimens, and he has also confused the two sexes in his figures of the gnathopods as well as in his description. Bate's specimens were sent to him by Say under the name *Gammarus minus* Say; but Say evidently misidentified his own species, for the specimens which he sent to Bate, under the name *Gammarus minus* Say, agree in no way with his description of this species. The specimens were then described by Bate as *Allorchestes knickerbockeri*. The specific name *knickerbockeri* has precedence of *dentata*, consequently the name of the species should be *Hyalella knickerbockeri* (Bate).

In some specimens of this species the dorsal spines are absent on the abdominal segments. These nondentate forms were first described by Prof. S. I. Smith, and were given the specific name *inermis*.

After comparing a large number of the dentate and nondentate forms I find they differ only in this one feature, and at present it seems best not to make this difference one of specific value; consequently, I have made *Hyalella inermis* synonymous with *Hyalella knickerbockeri*.

I have also compared Doctor Stebbing's type specimens of *Hyalella faxoni*, from Volcan Reventado, Costa Rica, with a number of specimens of *Hyalella knickerbockeri* and feel convinced that they belong to the same species. The differences which are pointed out by Doctor Stebbing between *Hyalella faxoni* and the nondentate forms of *Hyalella knickerbockeri* are very slight and are differences which are often found upon comparison of a number of specimens of the same species. The principal difference between the two, as pointed out by Doctor Stebbing, is the presence of three setæ on the inner plate of the first maxillæ of *Hyalella faxoni* instead of two. I have found specimens, however, from Yellowstone National Park and also from the Isle Royal, Lake Superior, which agree with *Hyalella knickerbockeri* in every detail, but on which I found three setæ on the inner plate of the first maxillæ; consequently this distinction between the two forms is not valid.

BIBLIOGRAPHY.

Bate, C. Spence. Catalogue of the Specimens of Amphipodous Crustacea in the Collection of the British Museum, 1862.

Benedict, J. E. Preliminary Descriptions of a New Genus and Three New Species of Crustaceans from an Artesian Well at San Marcos, Texas. Proceedings of the U. S. National Museum, XVIII, 1896, p. 616.

Cope, E. D. On the Wyandotte Cave and its Fauna. American Naturalist, VI, 1872, p. 406.

———. Descriptions of Species from Mammoth Cave. Annual Report of the Geological Survey of Indiana, 1872, p. 181.

De Kay, J. E. Zoology of New York, Part VI, Crustacea, 1844, p. 37.

Faxon, Walter. Exploration of Lake Titicaca by Alexander Agassiz and S. W. Garman. Crustacea. By Walter Faxon. Bulletin of the Museum of Comparative Zoology, III, 1876, pp. 361–375.

Forbes, S. A. List of Illinois Crustacea, with Description of New Species. Bulletin of the Illinois State Laboratory of Natural History, I, 1876, p. 6.

Hay, O. P. Notes on Some Fresh-water Crustacea, Together with Descriptions of Two New Species. American Naturalist, XVI, 1882, p. 241.

Hay, W. P. Observations on the Crustacean Fauna of Nickajack Cave, Tennessee, and Vicinity. Proceedings of the U. S. National Museum, XXV, 1902, p. 429.

Holmes, S. J. Phototaxis in the Amphipoda. American Journal of Physiology, V, 1901, p. 211.

———. Synopses of North American Invertebrates. XVIII. The Amphipoda. American Naturalist, XXXVII, 1903, p. 267.

———. Sex Recognition in Amphipoda. Biological Bulletin, V, 1903, p. 288.

Packard, A. S. The Fauna of Nickajack Cave. American Naturalist, XV, 1881, p. 880.

Say, Thomas. An Account of the Crustacea of the United States. Journal of the Academy Natural Science, Philadelphia, I, 1817, p. 374.

Smith, S. I. Preliminary Report on Dredgings in Lake Superior, 1871, pp. 1020–1026.

SMITH, S. I. Crustacea of the Fresh Waters of the United States. Report of the U. S. Commissioner of Fish and Fisheries, Part 2 for 1872–'73 (1874), pp. 637–665.

———. The Crustaceans of the Caves of Kentucky and Indiana. American Journal Science (3), IX, 1875, pp. 476–477.

———. Report on the Amphipod Crustaceans. Annual Report of the U. S. Geological Survey of Territories for 1873 (1875), pp. 608–610, pls. I–II.

———. Crangonyx vitreus and Packardii. Memoirs of the National Academy Science, IV, 1888, pp. 34–36.

SMITH, S. I., and VERRILL, A. E. Notice of the Invertebrata Dredged in Lake Superior in 1871, by the U. S. Lake Survey. American Journal of Science (3), II, 1871, pp. 448–454.

STEBBING, T. R. R. Amphipoda from the Copenhagen Museum and other Sources. Transactions of the Linnean Society, London (2), Zoology, VII, 1899, p. 423.

———. Amphipoda from Costa Rica. Proceedings of the U. S. National Museum, XXVI, 1903, p. 929.

ULRICH, C. J. A Contribution to the Subterranean Fauna of Texas. Transactions of the American Microscopical Society, XXIII, 1902, p. 85.

ON A NEWLY-FOUND METEORITE FROM SELMA, DALLAS COUNTY, ALABAMA.

By George P. Merrill,

Head Curator, Department of Geology, U. S. National Museum.

The information relating to the finding of the stone described below was sent the writer by Mr. John W. Coleman, to whom he is indebted for a small fragment and the privilege of describing, as well as information concerning its weight and general appearance.

The stone, as found, appears to have been a nearly complete individual, a piece of some three or four pounds weight only having been broken from one side. In shape it is roughly polygonal, without strongly marked flutings or pittings, and is considerably shattered and cracked, either from exposure or from the shock of striking the earth. (See Plate VI.)

The specimen received is without crust, and weathered to a dark reddish brown on the surface. Total weight of the stone, as reported, 310 pounds (140.6 kilograms). Greatest dimensions, as given by Mr. Coleman, 24 by 14 inches (60.96 by 35.5 centimeters); circumference, 69 by 44 inches (175 by 118 centimeters). Locality, 2 miles north and a little west of Selma, near the Summerfield road.

Although not found at the time, the date of fall is considered by Mr. Coleman as July 20, 1898, at about 9 o'clock in the evening. This is on the authority of various witnesses of "a great light passing from east to west, leaving behind it a trail of fire 10 or 12 feet long, and accompanied by a rumbling noise." One of the persons was so sure of the place of fall that a search was instituted for it at the time. There is, of course, no possibility of establishing absolutely the identity of the stone so recently found and the one seen to fall, but the close proximity of the localities makes it possible.

Additional data subsequently given by Mr. C. G. Gilbert, who visited the locality in the interests of the late H. A. Ward, are as follows:

The position of the stone, as found, was such as to suggest that it was first unearthed in the work of digging a trench for the purpose of laying a drain pipe and rolled one side, as would have been done

with an ordinary boulder, where it lay among the weeds until its true nature was surmised by Mr. Coleman.

As described by Mr. Gilbert in a letter to the writer, the stone at first sight is "a completely formless polyhedral block, but on longer inspection it resolves itself into something of a characteristic aerolite form—a blunt quadrangular pyramid with smooth, unpitted faces and rounded edges." (See Plate VI.) The thickness of the block he gives as 35.56 centimeters, the basal edges measuring, respectively, 35.56, 43.18, and 50.8 centimeters. The blunt apex of the pyramid—evidently the front side during flight—was covered for a distance of about 15.24 centimeters with a thin coating of carbonate of lime, which presumably marked the depth to which the stone penetrated on first striking the ground. This portion of the stone is smooth, except for the lime coating, and shows, as do the sides, the original though now oxidized crust. The base is, however, rough, with a somewhat scaly brown-black appearance, quite unlike the rest of the surface, and is divided by numerous fissures, due to weathering, as shown in fig. 3 of Plate VI. "The whole appearance," writes Mr. Gilbert, "indicates that it represents what was once a fine, large, well-orientated aerolite, many of the characteristics of which have become obliterated through exposure."

Macroscopically the stone is dense, of a dark-gray color, and sufficiently compact to receive a good polish. Cut surfaces show abundant "kugel" chondrules of all sizes up to 3 millimeters in diameter, though forms above 1.5 to 2 millimeters are rare. These are so firmly embedded as for the most part to break with the stone. The metallic portion is quite inconspicuous to the unaided eye.

Under the microscope in thin sections the stone is seen to be composed of extremely variable chondrules, often fragmental, and scattered particles of silicate minerals embedded in a dark opaque ground which, by reflected light, shows up as a network of deep-blue metallic iron and its oxidation products and brilliant points of yellow-white troilite. Olivine, enstatite, and a monoclinic pyroxene constitute the silicate portion. These are, in large part, in the form of fragmental chondrules, though sometimes quite perfectly oval. (Plate VII, fig. 1.) The olivine chondrules show the common barred and porphyritic forms, the latter with a more or less glassy or fibrous base. (Plate VII, fig. 2.) Some of them are mere aggregates of polarizing points without evident interstitial matter. There are also occasional large, scattered, single crystals and fragments not constituting chondrules. The enstatites occur under similar conditions and also in fan-shaped radiating forms, very much broken and otherwise imperfect (Plate VII, fig. 1), and in dense crypto-crystalline forms, presenting no opportunity for optical determination. (Plate VII, fig. 3.) The monoclinic pyroxenes are the least abundant of the silicates and show the usual (in

meteorites) polysynthetic twinning and low (15 to 20) angles of extinction. They are colorless or of a gray color and, but for the inclined extinctions, distinguished with difficulty from the enstatite. They occur in chondrules as well as in scattered isolated forms. No feldspars nor minerals other than those noted were observed.

The most striking feature of the stone is the broken and fragmental condition of the chondrules and the variety of forms manifested. It is best comparable, so far as the writer's experience goes, with that of Tieschitz, Moravia, described by Tschermak.[a] It belongs, therefore, to Brezina's class of kugel chondrites Cc. It will be known as the Selma, Alabama, meteorite, and is the fourth stony meteorite thus far reported from that State.

Since the above was written the stone has been purchased by the American Museum of Natural History, New York city.

EXPLANATION OF PLATES.

Plate VI.

Three views, drawn from photographs.

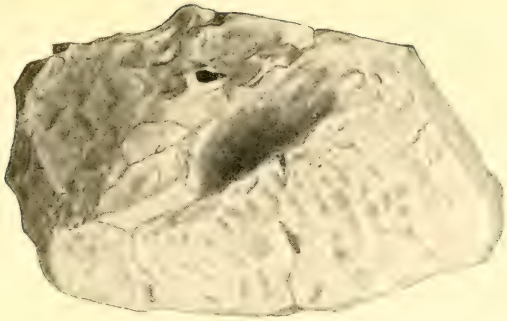
Plate VII.

Fig. 1. Showing microstructure and fragmental nature of olivine and enstatites. The amount of dark interspace is exaggerated by the oxidization of the ferruginous constituents.

2. Chondrule of porphyritic olivines.

3. Chondrule of cryptocrystalline enstatite.

[a] Denkschrift d. math.-Natur. Classe d. kaiserlichen Akad. der Wissen., XXXIX. 1878.



1

2

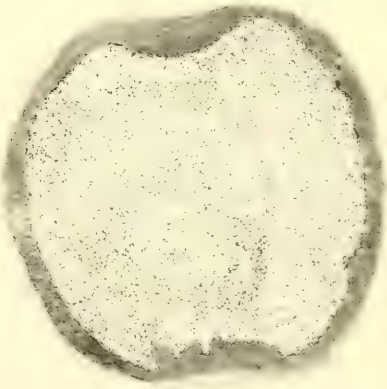
3

THE SELMA, ALABAMA, METEORITE.

FOR EXPLANATION OF PLATE SEE PAGE 61.

1

2



3

THE SELMA, ALABAMA, METEORITE.

FOR EXPLANATION OF PLATE SEE PAGE 61.

NEW MARINE WORMS OF THE GENUS MYZOSTOMA.

By J. F. McClendon,
Of Randolph-Macon College, Ashland, Virginia.

At the request of Dr. Richard Rathbun, Acting Secretary of the Smithsonian Institution, last May, I examined for myzostomes the crinoids and ophiurans in the Smithsonian Institution, other than those examined previously,[a] and found three new species and one new subspecies, besides one species previously described. To this list I have added two specimens of *M. clarki* sent to me by Doctor Rathbun too late to be considered in my former paper.

MYZOSTOMA CUBANUM, new species.

One specimen from Crinoid Cat. No. 16898, U.S.N.M., dredged by the U. S. Bureau of Fisheries' steamer *Albatross* at Station 2156, off Habana, 289 fathoms, April 30, 1884.

Diameter, 1.7 mm. Thickness, 0.8 mm. Yellowish brown, circular in outline, very flat on the dorsal surface, with 10 pairs of short conical cirri around the edge. Very convex (approximately hemispherical) on the ventral surface. The parapodia are prominent and decrease slightly in size toward the posterior end. The mouth and arms are very minute and are terminal in position. On the dorsal surface are peculiarly elevated areas with very much contorted outlines. The median one of these extends from the anterior to the posterior end. On each side of the median a primary, secondary, and tertiary set of

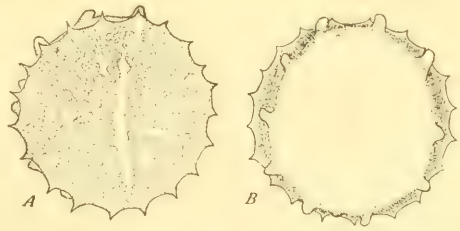


FIG. 1.—MYZOSTOMA CUBANUM. *A*, DORSAL VIEW; *B*, VENTRAL VIEW.

[a] The Myzostomes of the Albatross expedition to Japan, by J. F. McClendon, Bull. Am. Mus. Nat. Hist., XXIII, 1906, pp. 119–130, pl. XV–XVII.

shorter ridges radiate from the center toward the periphery. There are five primaries, three or four secondaries, and thirteen or fourteen tertiaries. The primaries are longest and nearest the center, the secondaries shorter and toward the periphery, the tertiaries shortest and at the periphery. Suckers are apparently absent.

Type—Cat. No. 5778, U.S.N.M.

MYZOSTOMA EVERMANNI, new species.

One specimen, 3 mm. in diameter, from Crinoid Cat. No. 21708, U.S.N.M., from Station 2166, off Habana, 196 fathoms, May 1, 1884.

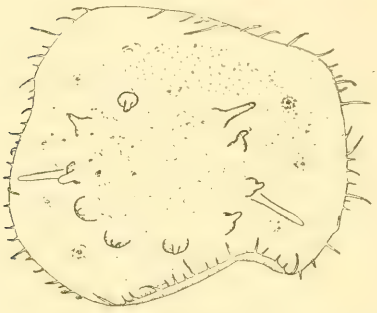


FIG. 2.—MYZOSTOMA EVERMANNI. VENTRAL VIEW.

Flat and nearly circular in outline. There are about eighty cirri around the edge of the animal. These cirri are of two sizes, alternating in position, the longer ones are a little less than one-tenth of the diameter of the Myzostome. The parapodia are prominent and are situated about midway between the center and the periphery of the ventral side. The penes are long and slender. Suckers with distinct mouths are situated about midway between the bases of the parapodia and the periphery. The border outside of the suckers is translucent, whereas inside of the suckers the body is opaque and light brown in color. The dorsal side is smooth.

This species seems most nearly related to *M. elegans* Graff, which is found in the Philippines.

Type—Cat. No. 5779, U.S.N.M.

MYZOSTOMA CERRIFEROIDUM, new species.

Thirty-one specimens, 0.8 to 2.5 mm. in diameter, from Crinoid Cat. Nos. 21707, 21709, and 21705, U.S.N.M., from Station 2753, St. Lucia, 281 fathoms, December 4, 1887, and Crinoid Cat. No. 21704, U.S.N.M., Station 2752, St. Lucia, 281 fathoms, December 4, 1887, and Crinoid Cat. No. 16895, U.S.N.M., from Station 2146, near Aspinwall, 34 fathoms, April 2, 1884.

This species is similar to *M. cerriferum*, but is thicker and usually has the lateral margins turned ventrally.

It is nearly circular in outline, brown, and has ten pairs of short cirri. The parapodia are prominent and situated a little nearer the margin than the center of the ventral side. No suckers are visible.

Type and cotypes—No. 5780, U.S.N.M.

MYZOSTOMA DEANI McClendon.

One specimen, 2.3 mm. long, from Crinoid Cat. No. 21706, U.S.N.M., from Station 3449, Straits of Fuca, 135 fathoms, August 28, 1891.

One specimen, 1.3 mm. long, from Crinoid Cat. No. 21701, U.S.N.M., Station 3350, Point Arena, California, 75 fathoms, September 25, 1890.

MYZOSTOMA CYSTICOLUM CYSTIHYMENODES, new subspecies.

One cyst from Crinoid Cat. No. 21703, U.S.N.M., from Station 2853, off the Trinity Islands, 159 fathoms, August 9, 1888.

This variety differs from *M. cysticolum* in size (being larger) and in the character of the cyst, which is not calcified as in the latter.

The cyst is ovoid and protrudes from the ambulacral groove of the arm of the Crinoid. It is 7.5 mm. long, and, in the slightly compressed state in which I received it, 4.5 mm. broad.

The larger individual in the cyst is 7 mm. long and the smaller 1.4 mm. in diameter.

Type.—Cat. No. 5781, U.S.N.M.

MYZOSTOMA CLARKI McClendon.

One cyst from *Metacrinus* sp., Station 3741, May 17, 1900. Length, 9.5 mm. The individual in the cyst was 6 mm. long.

These Myzostomes, and the Crinoids from which they were taken, are in the U. S. National Museum.

NOTES ON FISHES FROM THE ISLAND OF SANTA CATALINA, SOUTHERN CALIFORNIA.

By David Starr Jordan and Edwin Chapin Starks.

Of Stanford University, California.

The senior author visited the bay of Avalon on the island of Santa Catalina off the shore of southern California in May, 1906. While there he made a small collection of fishes, chiefly through the kindly interest of Dr. Charles Frederick Holder, of Pasadena, California,

Fig. 1.—Cypsilurus californicus (adult).

who was with him at the time, and of Miss Frances Lauderbach, an artist, then resident at Avalon. The accompanying drawings are by Mr. W. S. Atkinson and the photographs by Mr. Charles Ironmonger, of Avalon.

Several rare species were obtained, most of them being fishes which had died at the local aquarium, and had been turned over to Doctor Holder, or to Miss Lauderbach.

Family EXOCŒTIDÆ.

CYPSILURUS CALIFORNICUS (Cooper).

A flying-fish, 3 inches in length, collected at Avalon by Doctor Holder, is apparently the young of the large Catalina flying-fish. It differs from the adult in color. The greater part of the body is colorless, translucent in life, and covered with fine points of brown, which forms large irregular blotches opposite the dorsal fin. Pectoral dark brown, with transparent blotches; a round one near base of upper

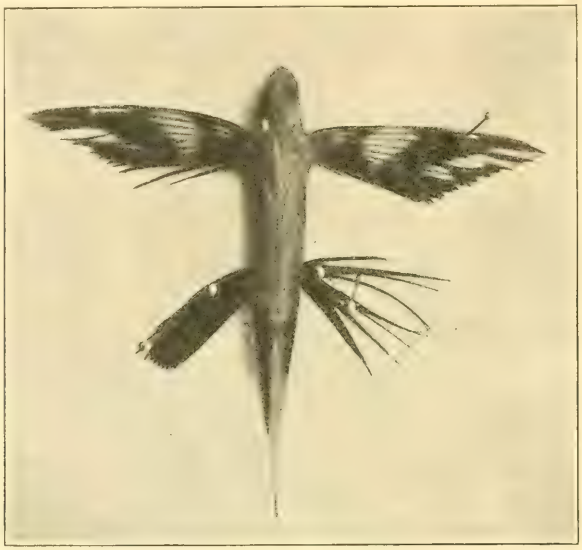


FIG. 2.—CYPSILURUS CALIFORNICUS (YOUNG).

pectoral rays; another somewhat triangular in shape at middle of fin nearly crossing the entire fin; the last an irregular streak near ends of rays following the posterior outline of the fin; ventrals bluish black, darker than other fins; dorsal slightly dusky; a light inconspicuous blotch near front of fin; anal dusky brown, the first one or two rays colorless; caudal colorless, except the faintest trace of two dusky spots on lower lobe; one near middle of rays, the other near tips of rays.

Family POLYNEMIDÆ.

POLYDACTYLUS APPROXIMANS (Lay and Bennett).

(*Polynemus californiensis* Thominot.)

This species, common about Mazatlan, has been once taken at Santa Catalina and once at San Diego.

Family LAMPRIDÆ.

LAMPRIS REGIA (Bonnaterre).

The opah is occasionally taken about Santa Catalina; two stuffed specimens were seen.

Family SCOMBRIDÆ.

GERMO MACROPTERUS (Schlegel).

The yellow fin albacore, Hirenaga of the Japanese fishermen, has been in the past two years occasionally taken off Avalon. It is a common fish of southern Japan, and is occasionally taken about Hawaii. From the ordinary albacore, *Germo alalonga*, abundant about Santa Catalina, this species is known by the citron yellow finlets and by the very high soft dorsal and anal.

In the Hawaiian report of Jordan and Evermann this species, known in Hawaii as Ahi, is described, under the incorrect name of *Germo*

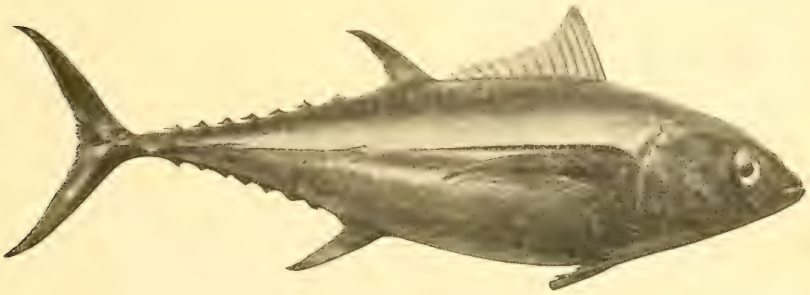


FIG. 3.—GERMO MACROPTERUS.

germo, which name belongs to a near relative of the common Albacore. The figure, copied by Jordan and Evermann from Schlegel's figure of "*Thynnus sibi*," belongs to *Germo germo*, of which *Germo sibi* is apparently a synonym.

The following description of *Germo macropterus* is taken from a Hawaiian example:

Head $3\frac{3}{5}$ in length to base of caudal; depth $3\frac{3}{4}$; eye $5\frac{1}{2}$ in head; snout 3; maxillary $2\frac{4}{5}$; DXIV—II, 12+VIII. A II, 12+VI.

Body stout, fusiform; dorsal and ventral curves gradual, the body deepest at the middle. Head sharply conic; snout pointed; jaws subequal; maxillary reaching to opposite middle of pupil; teeth in jaws in one row; small, bluntly conic; a patch of villiform teeth on vomer, none on palatines. Eye large; caudal peduncle at narrowest point half depth of eye. First dorsal spine $2\frac{1}{2}$ in head; soft dorsal and anal similar, elevated, falcate, the longest ray 3 in head; pectoral long and slender, as long as head, reaching front of anal; caudal lobes each $1\frac{3}{10}$ in head, ventrals $2\frac{7}{10}$. Scales small, those on shoulder forming a distinct corselet. Color in life dark blue with steely reflections, silvery below; traces of very faint pale bands separated by rows of very faint spots curved backward below on lower part of body; soft dorsal and anal yellow, the finlets bright lemon yellow; caudal dusky white, with yellow border; ventrals white on lower surface, black above, with a

small black spot on base; pectoral very dark blue, above, black on inner surface, silvery grayish blue on outer surface.

This species has been occasionally taken on the hook in the last two years about Avalon. It was first noticed as a California fish by Doctor Holder.

GYMNOSARDA PELAMIS (Linnæus).

This species, the "Oceanic Bonito," is frequently taken about Santa Catalina and San Diego. It is common in Hawaii and Japan.

Family LEPIDOPIDÆ.

LEPIDOPUS XANTUSI Goode and Bean.

One specimen, $2\frac{1}{2}$ feet long, from Avalon.

Head $4\frac{1}{2}$ in length. Depth at front of dorsal $2\frac{2}{5}$ in head; eye $5\frac{2}{3}$; snout $2\frac{9}{10}$; maxillary $2\frac{5}{6}$; dorsal rays 80; anal I, 46.

Body long and slender, tapering to a very narrow caudal peduncle. Head deeper than the body. Upper profile of head nearly straight from front of dorsal to premaxillary processes, where the outline is

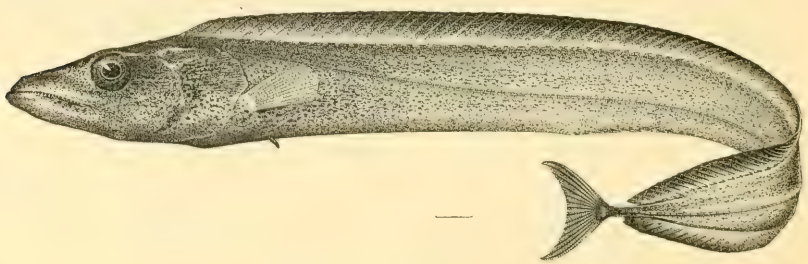


FIG. 4.—LEPIDOPUS XANTUSI.

angulated and descends obliquely; supraorbital rim slightly prominent. Gape rather strongly curved; lower jaw projecting and hooked upward at its tip. A single row of sharp flattened teeth at edge of jaws, growing smaller anteriorly; near front of upper jaw are two pairs of long sharp dagger-shaped canines, a little inside of the smaller lateral teeth. Maxillary extending nearly to front of pupil; its posterior part almost entirely concealed by the preorbital. Interorbital space concave at its middle portion; the outer edges nearly flat; its width three-fifths of diameter of orbit. Skin of side of head continuous over preopercle. Gillrakers slender, stiff, and needle-like; the length of the longest a little less than that of the canines, their number 9+11; some of them interspaced by much smaller ones (not included in the above count).

Origin of dorsal from tip of snout equal to distance from tip of mandible to edge of preopercle; longest dorsal rays inserted about the head's length behind head, contained five times in head. Anterior anal rays covered by the skin, the posterior rays shorter than the dor-

sal rays above them; the last anal ray connected to caudal peduncle by membrane. On a small specimen, 5½ inches long, collected at San Jose del Cabo, Cape San Lucas, Mexico, there is a large pen-shaped second anal spine having a strong median keel. This is lost in our specimen and a single flat blunt spine only is present. Pectoral fin rounded; its length a little less than that of snout. Ventral represented by a single flat spine, inserted a little behind base of pectoral; its length equal to that of anterior canine. Caudal wide; its posterior edge lunate.

Color dark brown, everywhere speckled with small irregular spots of black; head a little darker than trunk; lateral line a little darker than surrounding color. Dorsal light at base, growing dark toward tips of rays; anal more uniformly dusky; caudal black; pectoral dusky toward tip. Inside of gill cover, mouth, and body cavity coal black. Here described from a specimen 30 inches in length collected by Dr. C. F. Holder, at Catalina Island.

It was previously known from two very small specimens taken at Cape San Lucas—the one by John Xantus, the other by Richard C. McGregor.

Family XIPHIIDÆ.

XIPHIAS GLADIUS Linnæus.

The swordfish is occasionally taken about Santa Catalina. It has been seen by the writers off Santa Barbara, Santa Catalina, and San Diego.

Family ISTIOPHORIDÆ.

TETRAPTURUS MITSUKURII Jordan and Snyder.

MARLIN-SPIKE FISH.

This species, not rare in Japan, is occasionally taken off Santa Catalina, where it is known as marlin-spike fish. A specimen taken August 17, 1904, 8 feet, 8 inches long, weighed 120 pounds. Another 12 feet long is on record.

FIG. 5.—TETRAPTURUS MITSUKURII.

Family CARANGIDÆ.

NAUCRATES DUCTOR Linnæus.

One specimen of this oceanic species was obtained. We are unable to separate it from the pilot fish of the Atlantic. A specimen from Misaki, Japan, in Stanford University, is apparently also referable to *Naucrates ductor*. We have seen no Pacific specimens as deep in body or as large scaled as *Naucrates polysarcus*, lately described from the west coast of Mexico by Mr. Henry W. Fowler.

Family LUVARIDÆ.

LUVARUS IMPERIALIS Rafinesque.

A specimen of this widely diffused oceanic fish was taken at Avalon by Doctor Holder.

Family POMACENTRIDÆ.

CHROMIS PUMCTIPINNIS (Cooper).

This species, very abundant about Santa Catalina, is, in life, of a milky sky blue.

Family BALISTIDÆ.

BALISTES CASTANEUS Richardson.

(*Balistes polylepis* Steindachner.)

A specimen of this species was seen in the aquarium at Avalon. We have also an example taken at Santa Catalina by Mr. T. Shooter.

Family PLEURONECTIDÆ.

CITHARICHTHYS STIGMÆUS Jordan and Gilbert.

This little flounder, otherwise rare, is common on the sands of Avalon Bay.

Family REGALECIDÆ.

REGALECUS RUSSELLI (Shaw).

A specimen of oar-fish has been taken at Newport, Orange County (February 22, 1901). It was 22 feet in length and weighed 500 to 600 pounds. Others, old and young, have been taken about Avalon, but none have been preserved. An account of these is given by Jordan.[a] Doctor Holder thus speaks of a specimen 2 feet long taken at Avalon. "Its topknot (it can be compared to nothing else) was a vivid red or scarlet mass of seeming plumes. These dorsal plumes merged into a long dorsal fin extending to the tail. The color of the body was a

[a] Guide to the Study of Fishes, II, p. 474.

brilliant silver sheen, splashed with equally vivid zebra-like stripes, which gave the fish a most striking appearance. The fish was a fragile and delicate creature, a very ghost of a fish, which swam along, when the water gently lapped the sands, with an undulatory motion, looking like one of its names—the ribbon-fish."

Family BLENNIIDÆ.

STARKSIA HOLDERI Lauderbach, new species.

Head $3\frac{1}{2}$ in length to base of caudal; depth 5; eye 4 in head; snout 3; maxillary $2\frac{1}{4}$; dorsal XXV, 11; anal II, 23; scales 51.

Maxillary extending back to below posterior edge of pupil. Jaws even in front; the lips rather thick. An outer series of rather large blunt teeth on sides and front of jaws, the anterior ones slightly the larger; behind these a band of villiform teeth wide in front but tapering quickly to a point at sides of jaws; the band wider and extending a little farther back on upper jaw than on lower; a band of similar teeth on vomer, and a rather large ovate patch on front of each palatine, not continuous with vomerine patch. A fringed tentacle on

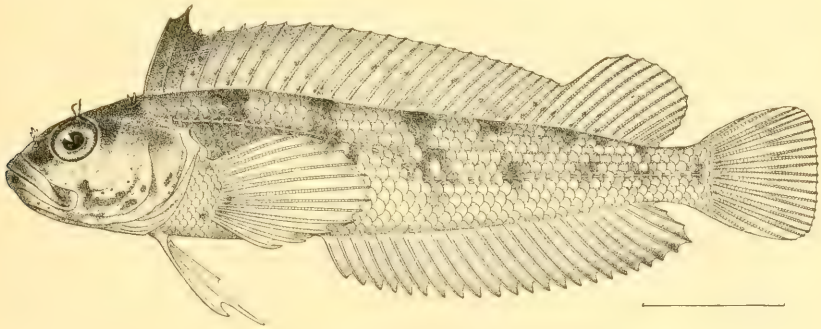


FIG. 6.—STARKSIA HOLDERI.

anterior nostril; a pair of simple filaments above each eye, each pair springing from a common base; their length equal to diameter of pupil; a shorter trifid flap at nape, its separate filaments united only at base. Interorbital space flat; its width equal to one-half diameter of eye. Top of head with rather large conspicuous pores. Inner edge of shoulder girdle with a sharp ridge ending abruptly opposite upper end of pectoral base and forming a slight notch, but no hook present. Gill membrane broadly united, free from isthmus.

Head and fins naked; rather large cycloid scales on body; two scales between middle of lateral line arch and outline of back; five scales between posterior angle of lateral line and ventral outline of body; arched part of lateral line scarcely shorter than straight part.

Second dorsal spine the longest, its length equal to postorbital part of head; behind the second spine the outline of the fin is concave; the

spines increasing in length to middle of spinous portion; the longest middle spines contained 2½ in head; the spines next to soft dorsal are half the length of anterior soft rays which are a little longer than the second spine. Anal low; its posterior rays the longest; their length 2⅓ in head; anal spines differentiated from anal rays only by the absence of cross articulations. Lower pectoral rays slightly thickened. Ventral with one spine and 2 rays; the inner ray the longer, nearly reaching to vent; its length equal to length of head without snout. Caudal truncate.

Color in spirits light gray, with 7 slightly darker inconspicuous crossbars half as wide as eye; dark lines following the rows of scales side of head slightly mottled with slate color; a slate-colored blotch at tip of mandible and indications of bars on lower side of head of similar color. Spinous dorsal dark in front growing light backwards; anal dusky; the tips of the rays lighter; pectoral dusky at base; caudal slightly soiled with dusky.

The type and sole specimen is 94 mm. in length and is Cat. No. 56397, U.S.N.M.

This species is named for Dr. Charles Frederick Holder. It is referred provisionally to the genus *Starksia*. From the type of that genus, *Starksia cremnobates*, it differs in the presence of nuchal filaments, in the smaller scales, and in larger numbers of fin rays. It may prove to be the type of a distinct genus.

CHÆNOPSIS ALEPIDOTA (Gilbert).

(*Lucioblennius alepidotus* Gilbert).

The following description is of three specimens, two of them males, from Avalon Bay, from 125 to 165 mm. in length.

Head 3⅘ in length. Depth 3½ in. head; eye 7½ to 8½; snout 4½ to 5, maxillary 1¾. Dorsal XIX or XX, 36 to 38; anal II, 37 or 38.

Head very pike-like; the lower jaw thin and projecting, the snout sharp and its outline straight from eyes to its point, as viewed from the side; as viewed from above it is rather broad and rounded in front. Maxillary long, reaching far past eye, its upper edge behind eye slipping under a dermal sheath. A row of even enlarged teeth in jaws and a band of villiform teeth behind them in front; a single row of rather large blunt teeth on palatine and a few very small teeth on vomer. The latter are scarcely to be seen until the jaws are dried. Interorbital space narrow, its width half diameter of eye.

Dorsal commencing at nape, running continuous to caudal; its last ray joined to base of caudal by membrane. Dorsal spines distinguished from soft rays by being more slender and lacking cross articulations; none of the rays branched. In the female the spines are no higher than the rays; the longest equal to the length of the snout. In the male the spines and the membrane between them are greatly elevated and are from one and one-half to two times greater than the depth of

the body. The slender spines and thin, soft membranes of the dorsal resemble in texture the pectoral fins of *Cephalacanthus*. Anal a very little lower than the dorsal and posteriorly connected with the caudal. Caudal rather short and broadly rounded, without an angle at tips of outer rays. Pectoral rounded, its rays simple; its length from 2⅓ to 2½ in head; ventral with one spine and three rays; the middle ray the longest, as long as distance from tip of snout to middle of eye or sometimes a little longer; the first ray somewhat shorter, and the third ray very slender and closely attached to the second ray which is fully three times longer; it is inconspicuous and might easily be overlooked.

Color in spirits, light grayish brown, with eleven dark brown short crossbars or blotches on the middle of the side fading out above and below; some of the anterior blotches more or less separated into two spots; sides with or without small round light spots, irregular in size and bordered with dusky color slightly darker than the surrounding color, small dusky spots of irregular size on top of head and smaller sharper dark spots along back (these only conspicuous on the largest specimen). Ventral fins and branchiostegal membrane of female slightly

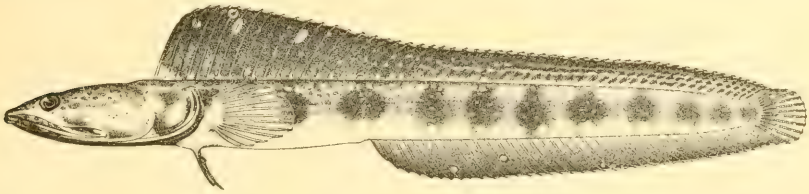


Fig. 7.—Chænopsis alepidota.

dusky; those of male, coal black, with bluish reflections; pectoral slightly dusky in both sexes. Spinous dorsal of female light with a few dusky bands across the rays; soft dorsal similarly marked, but the cross lines more numerous and closer together; the color fading out posteriorly and the fin nearly colorless; a small black spot ocellated with a light ring between the first and second spines; anal and caudal colorless. Spinous dorsal of male coal black; soft dorsal growing black toward outer edge, with a narrow border of colorless membrane and rather thickly covered with small round light spots; caudal dusky with similar spots; anal growing black toward ends of rays like the soft dorsal, but unspotted.

The following notes are by Miss Lauderbach, from whom the specimens were obtained:

The largest specimen was caught from the end of the wharf at Avalon with hook and line. When in the aquarium it snapped viciously at every approaching hand. In swimming the body was flexible and eel-like. A favorite movement was to squirm backward into small crevices between the rocks, leaving only the mouth at the entrance. It repeatedly jumped from the tank.

One of the 2 typical specimens of *Lucioblennius alepidotus* from Guaymas, Mexico (No. 72 Stanford University), has the dorsal XX, 35 and the anal II, 35, as shown in the drawing published by Jordan.[a]

The genus *Lucioblennius* Gilbert, based on a young specimen of this species, is doubtless inseparable from *Chænopsis*.

Family ANTENNARIIDÆ.

ANTENNARIUS AVALONIS Jordan and Starks, new species.

Dorsal iii–12; anal 8. Depth 2 in length to base of caudal. Eye 2 in space from eye to base of second dorsal spine; 2 in preorbital space without premaxillary. Maxillary 3½ in length. Upper jaw vertical. Teeth slender, sharp, and slightly recurved; in broad bands on jaws; similar teeth on vomer and palatines; on the former in 2 ovate

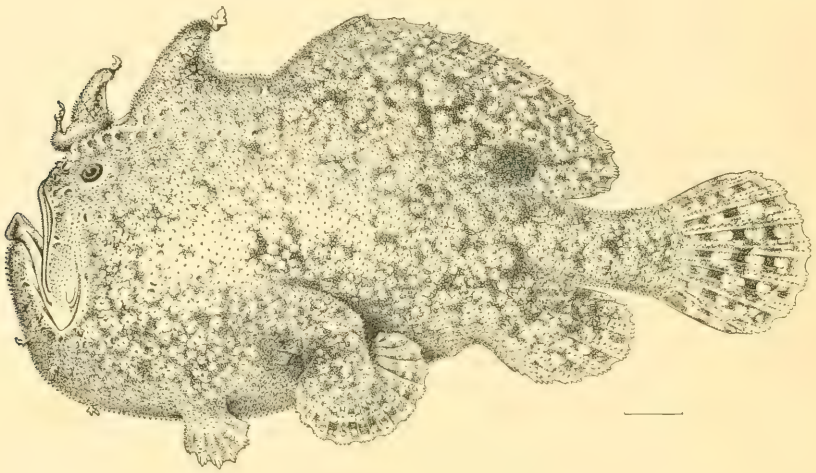


FIG. 8.—ANTENNARIUS AVALONIS.

patches separated at the median line; in a single short, irregular row on each palatine. A conspicuous knob at symphysis.

First dorsal spine broken; second spine not hooked at the tip, ending in a fleshy tentacle; length of spine equal to distance from its base to lower edge of eye; no pit behind it; third dorsal spine much longer and stronger than second, scarcely diminishing in size from its base to its tip, ending in a fleshy flap of skin; it is rather freely movable, but moderately bound to the body for its full length by skin; between its tip and outline of back the skin is concave; pectoral very thick, the lower surface with plicate ridges and short, thick papillæ.

Skin covered with rather coarse bifurcate spines; second and third dorsal spines closely covered with simple and bifurcate spines, and similar spines follow the fin rays nearly to their tips; premaxillary

[a] Proc. Cal. Acad., 2d ser., VI, pl. XXXVII; not dorsal XVIII, 32 and anal II, 30 as originally described.

naked upper end, and a patch down middle of maxillary with spines, lower end, anterior margin and an area behind maxillary naked; a wide area on each side of the mandible naked; a saddle-like patch behind second dorsal spine naked; lines of spinous tubercles surrounded by small naked areas most conspicuous at base of second dorsal spine; a few following edge of preopercle and side of body; three or four scattered over cheek and maxillary; a few large fleshy flaps on mandible and lower part of head.

Body, head, and fins irregularly mottled with a network of dark and light-brown lines around spots of white; dark, very irregular bars on caudal, more broken and less evident on other fins, though no lighter; an irregular spot at base of last dorsal rays irregularly and inconspicuously ocellated; inside of mouth light brown.

The type is 13½ inches in length, and is numbered 9979 in the Stanford University collections. A specimen obtained previously at Avalon was lost or destroyed.

This species differs from *Antennarius strigatus* in color; there being no stripes or bars apparent anywhere; and the third dorsal spine is considerably free, not developed as a hump. A specimen of *A. strigatus* from Panama (possibly referable to another species), 10 inches long, is described as being covered with fine shagreen-like armature. The armature of *A. avalonis* could scarcely be called fine or shagreen-like. The species differs from *Antennarius tagus* Heller and Snodgrass, in having no deep pit behind second dorsal spine; the tip of second spine not strongly bent backward, but ending in a fleshy flap; the naked areas on sides of mandible larger; in having short fleshy tentacles under mandible; in having the fins thicker, lower, and the underside of pectorals plicate and papillose. The color is darker than in *A. tagus* and of a different pattern.

NOTES ON THE COMPOSITION AND STRUCTURE OF THE HENDERSONVILLE, NORTH CAROLINA, METEORITE.

By George P. Merrill,
with chemical analyses by Wirt Tassin,
Of the U. S. National Museum.

All the information available concerning the fall, the finding, and general appearance of the stone here described was given by Prof. L. C. Glenn more than two years ago,[a] with the expectation at that time that the paper here given would shortly follow. Through various causes the matter has been delayed until the present.

According to Professor Glenn, the stone undoubtedly fell in or about 1876, but none of it was found until 1901. The mass, as received by him, weighed 11 pounds and 6 ounces (5.17 kilograms), but the original weight was considered as probably some 2 pounds greater, two pieces having been broken off and used in making an assay. The total weight of the original was, then, probably not far from 6 kilograms. The shape of the mass is shown in Plate VIII, fig. 1, being the stone as received by Professor Glenn, and fig. 2 that of the portion secured for the U. S. National Museum (Cat. No. 85264). Resting on its base, the stone is very nearly cubical, the dimensions being 15.5 cm. by 15 cm. by 14 cm. It is firm and hard, without cracks, notwithstanding its long exposure, though considerably rusted throughout the interior.

In structure the stone is kugel chondritic and under the microscope presents, so far as observed, no very unusual features. Two pyroxenes, enstatite and a monoclinic form, and olivine make up the silicate portion, with the usual sulphides and metallic portion. The general microstructure of the stone is shown in figs. 1 and 2 of Plate IX. The "kugels" of radiating and cryptocrystalline enstatites are of a gray color and sharply differentiated from the groundmass, though usually breaking with it (fig. 1., p. 80). Chondrules of the ordinary porphyritic

[a] American Journal of Science, XVII, 1904, p. 215.

enstatite and olivine type are common, also of the grate and barred type of the latter mineral (fig. 2, Plate IX). The groundmass consists of an aggregate of olivines, enstatites, and augites, with the customary sprinkling of metallic iron. No true glass was observed. As usual, the monoclinic pyroxene is of much the same general appearance as the enstatite, but readily distinguished therefrom by its inclined though low angle (18 –25) of extinction. The structure as a whole is much confused, a feature common to stones of this class.

The most interesting feature is the presence of occasional small areas like that shown near the center in fig. 1, Plate IX. This, under a low power, has all the appearance of a fragment of clastic rock composed of rounded and irregular particles, all of the same mineralogical nature (in this case olivine), embedded in a cement seemingly irresolvable but showing polarizing points. Under as high a power as the thickness of the section warrants using, this interstitial material is seen to polarize faintly and to have a granular to fibrous structure. In some instances indistinct finger-like prolongations extend out from the borders of the granules into the interstices. The structure is not at all that of minerals crystallizing freely from a molten magma, but is suggestive of a partial recrystallization of fine detrital material, as seen in sundry metamorphic schists. The same feature is shown in the fine interstitial portions of fig. 2 of the same plate. It is practically impossible to cut sections thin enough to enable one to write as definitely as desirable, but the structure in both these cases is strongly suggestive of that seen in the meteorite of Kernouvé, France, and which F. Rinne,[a] following Tschermak, regards as due to a mechanical trituration and resintering from a subsequent elevation of temperature.

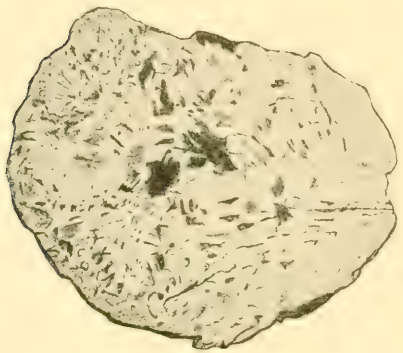


FIG. 1—ENSTATITE CHONDRULE OUT OF HENDERSONVILLE METEORITE.

The chemical composition of the stone, as worked out by Mr. Tassin, is as follows:

The portion taken for analysis was badly oxidized. It was therefore kept for some time at a temperature below red heat in an atmosphere of hydrogen.

The nickel iron was determined in a portion of the mass weighing 2.100 grams. This was pulverized and treated with a solution of mercuric

[a] Neues Jahrb. fur Min., etc., II, 1895, p. 229.

ammonium chloride (12 grams of the double salt, $HgCl_2.2NH_4Cl.2H_2O$, to the liter) in an atmosphere of hydrogen. The native metals thus separated were in the following proportions:

Constituents.	Found.	Calculated to 100.
	Per cent.	*Per cent.*
Fe	2.37	91.51
Ni	.21	8.11
Co	.01	.38

The sulphur was determined in a 1.01-gram sample after fusion with sodium carbonate and potassium nitrite. The amount found was 1.61 per cent, which corresponds to 4.43 per cent of troilite. The phosphorus was determined in a 1.5235-gram sample, and 0.012 per cent was found, which corresponds to 0.08 per cent of schreibersite.

The separation of the silicates was effected in a 2.63-gram fragment by treating the finely pulverized mass with dilute hydrochloric acid, specific gravity 1.06, on the water bath for two hours, repeating this operation twice, followed by boiling the moist residue of undecomposed silicate with a solution of sodium carbonate, since the major part of the silica of the soluble silicate will be here found.

The analysis of the soluble silicate gave:

Constituents.	Found.	Calculated to 100.
	Per cent.	*Per cent.*
SiO_2	15.66	38.34
FeO	9.44	23.10
Al_2O_3	0.20	0.49
Cr_2O_3	0.03	0.07
CaO	0.15	0.36
MgO	15.38	37.46

The insoluble silicates, analysis below, were decomposed by fusion with sodium carbonate. The alkalies were determined in a separate portion.

Constituents.	Found.	Calculated to 100.
	Per cent.	*Per cent.*
SiO_2	30.40	56.01
FeO	4.89	9.01
Al_2O_3	2.00	3.68
Cr_2O_3	0.20	0.37
CaO	1.98	3.65
MgO	13.24	24.39
K_2O	0.10	0.18
Na_2O	0.96	1.77
Chromite	0.51	0.94
	54.28	100.00

The general composition of the meteorite may be arrived at by combining the results of the several determinations, thus:

	Per cent.
Fe	2.37
Ni	0.21
Co	0.01
S	1.61
P	0.012
SiO_2	46.06
FeO	14.33
Al_2O_3	2.20
Cr_2O_3	0.23
CaO	2.13
MgO	28.62
K_2O	0.10
Na_2O	0.96
Residue (chromite)	0.51
	99.352

From these several analyses it is possible to arrive at the following approximation of the relative quantities of the different constituents:

	Per cent.
Nickel iron	2.59
Troilite	4.43
Schreibersite	.08
Chromite	.80
Olivine	40.48
Pyroxenes	51.62
	100.00

In the above the amount of the nickel-iron is given as directly determined. The sulphide and phosphide of iron are calculated from the amount of sulphur and phosphorus found; the chromite is similarly calculated. The soluble silicate is regarded as olivine; the insoluble silicate as being largely enstatite, with some augite.

EXPLANATION OF PLATES.

PLATE VIII.

The Hendersonville, North Carolina, Meteorite.

FIG. 1. The stone as it came into the possession of Professor Glenn.

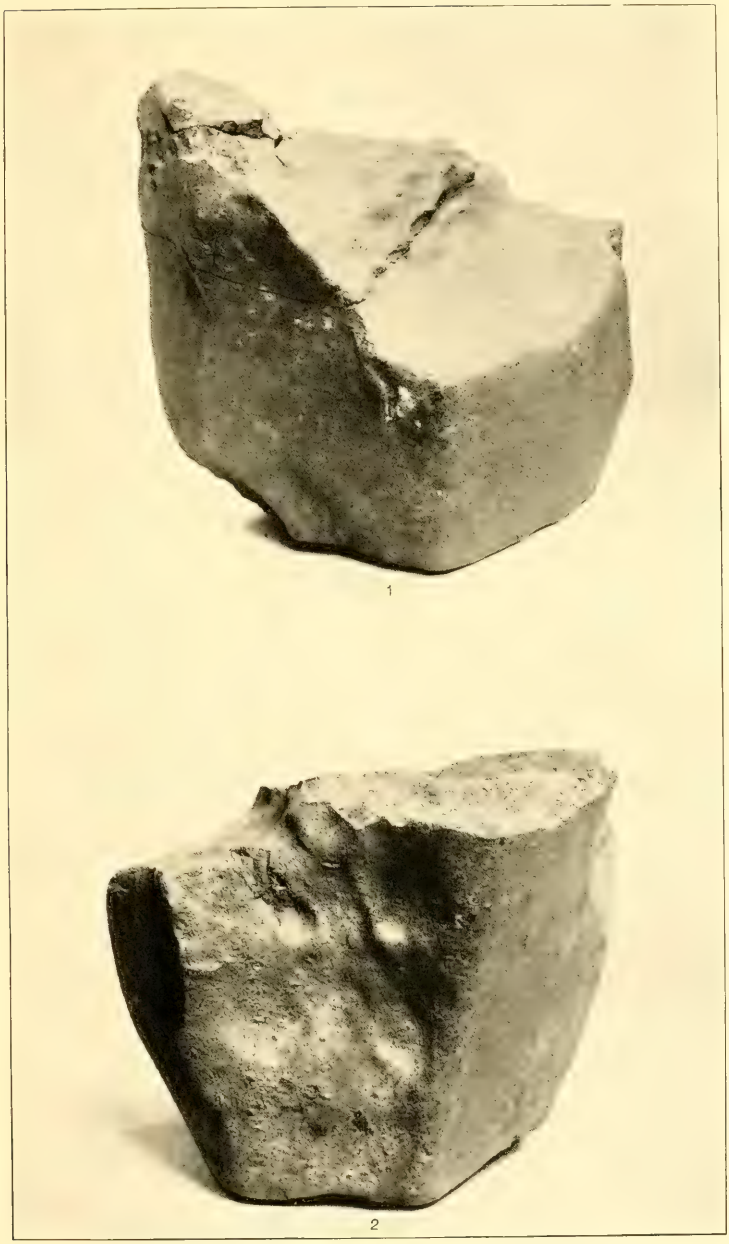
2. The portion of the stone now in the U. S. National Museum, viewed from side opposite to that shown in fig. 1.

PLATE IX.

Microstructure of Hendersonville, North Carolina, Meteorite.

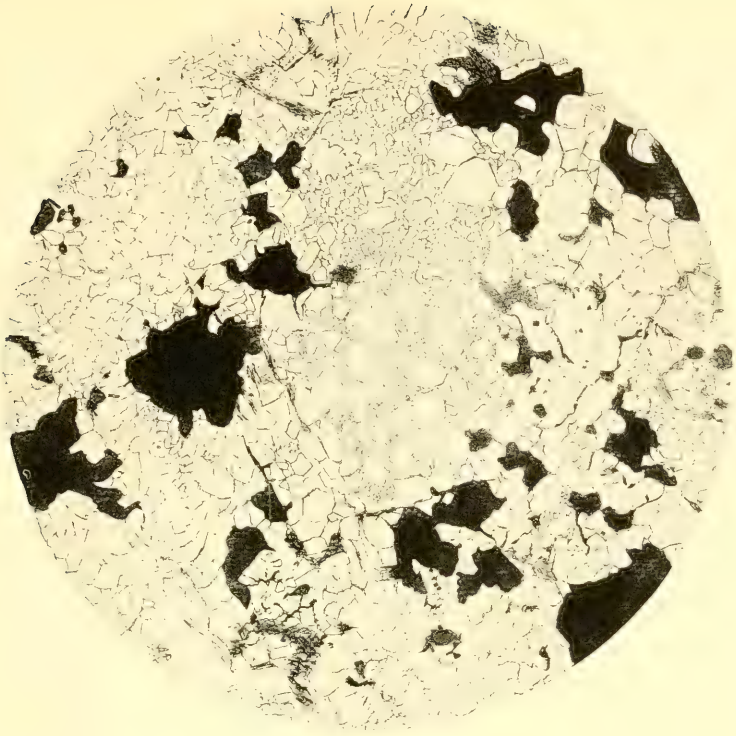
FIG. 1. Black areas, metallic iron and iron sulphide; light, olivines and enstatite. Near the center an indistinctly chondritic mass with structure suggestive of sintering of finely pulverized olivines.

2. Light and dark areas as in fig. 1. At the bottom an olivine chondrule. Large colorless areas in the upper left quadrant are enstatites. The section shows to advantage the finely pulverulent granular structure characteristic of much of the interstitial matter.

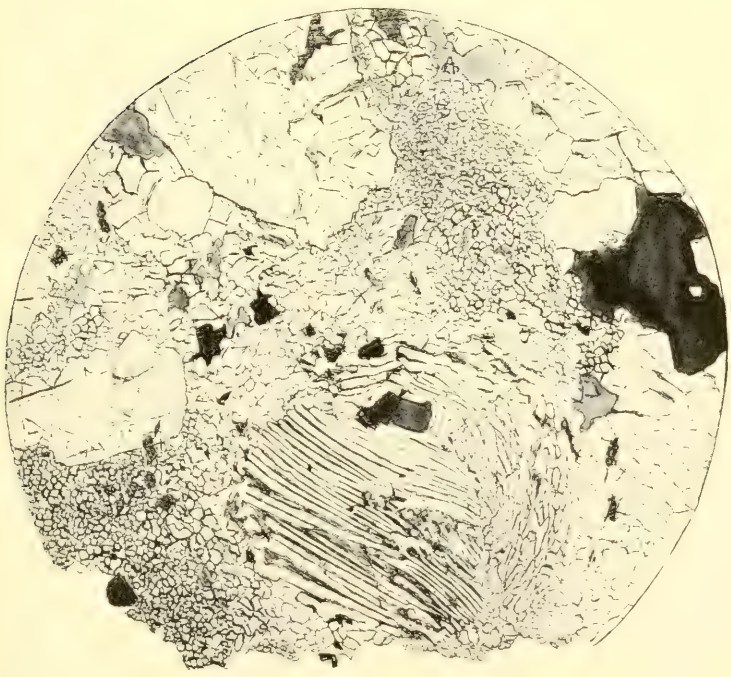


THE HENDERSONVILLE, NORTH CAROLINA, METEORITE.

FOR EXPLANATION OF PLATE SEE PAGE 82.



1



2

MICRO-STRUCTURE OF HENDERSONVILLE, NORTH CAROLINA, METEORITE.

FOR EXPLANATION OF PLATE SEE PAGE 82

THE PHILIPPINE MOLLUSKS OF THE GENUS PLANORBIS.

By Paul Bartsch,

Assistant Curator, Division of Mollusks, U. S. National Museum.

Up to date only two species of *Planorbis* have been known from the Philippines. To these Maj. E. A. Mearns's explorations in Mindanao have added two new forms, which are described and figured in the present paper.

PLANORBIS (GYRAULUS) QUADRASI Möllendorff.

Planorbis (*Gyraulus*) *quadrasi* Möllendorff, Bericht. Senck. Nat. Ges., 1903, p. 115, pl. III, figs. 11, 11a–11c.

The type locality for this species is Montalban, Luzon. The type is said to have three whorls and measures: Greater diameter, 3.5 mm.; altitude, 1 mm. Von Möllendorff also reports it in the same publication from the island of Leyte. His figure shows almost four instead of three whorls as cited in the description.

PLANORBIS (GYRAULUS) MINDANENSIS, new species.

Shell lenticular, biconcave, thin, semitransparent, corneous. Upper surface decidedly more concave than the lower, showing all the whorls, which increase evenly and rapidly in size. The entire upper surface

FIG. 1.—PLANORBIS (GYRAULUS) MINDANENSIS.

is marked by numerous, quite prominent, irregularly developed lines of growth. Periphery of the last whorl marked by a slender keel. The basal parts of the whorls are a little more convex than the upper sides, with the incremental lines less strongly developed. The center

of the base is only slightly depressed below the plane of the last whorl; in fact the most convex part of all of the whorls on the base falls almost in an even plane. The turns are separated above and below by well-impressed sutures. Aperture quite large, suboval, decidedly oblique, angulated at the middle of the outer lip by the slender keel. Columella practically absent; parietal wall covered with a thin callus.

The type has four and one-fourth whorls and measures: Greater diameter, 6.7 mm.; lesser diameter, 5.7 mm.; altitude, 1.7 mm.

The type and 196 specimens, Cat. No. 192982, U.S.N.M., were collected in Lake Buluan, Rio Grande Valley, province of Cotabato, Mindanao.

PLANORBIS (HELICORBIS) LUZONICUS Möllendorff.

Planorbis (*Hippeutis*) *luzonicus* MÖLLENDORFF, Nachr. Mal. Ges., XXVII, 1895, p. 120.

The shells described were collected by natives near the village Libmanan, in the province Camarines, Luzon. The measurements given for the type, which has five whorls, are: Greater diameter, 10.5 mm.; lesser diameter, 9 mm.; altitude, 3 mm.

PLANORBIS (HELICORBIS) MEARNSI, new species.

Shell lenticular, vitreous, horn color. Whorls increasing regularly in size, the last enveloping the greater part of the previous turns. All of the whorls show evenly coiled on the dorsal surface in the

FIG. 2.—PLANORBIS (HELICORBIS) MEARNSI.

extremely regularly conically depressed apex. The last half turn only, deviates from the regular spiral in having the summit gradually deflected until it falls about halfway between the summit and periphery on the preceding turn, at the aperture. The angle at the junction of the outer wall and the parietal wall is filled up for a short distance, and this shows through the shell as a moderately broad solid band, and makes the whorls appear as if they had a double suture. The whorls are evenly rounded on the dorsal surface and marked by moderately strong incremental lines only. Sutures lightly impressed. Periphery of the last whorl bluntly but strongly angulated. Base almost flat, with a moderately broad umbilicus, in which the whorls can be seen regularly and evenly coiled, but here also the last half of the last one becomes more and more openly coiled until it reaches

a point at the aperture, about one-third of the distance toward the periphery from the umbilicus to the periphery. The base, like the upper surface, is marked by numerous incremental lines. Aperture decidedly oblique, arrow shaped, the apex falling at the periphery, and the two barbs above and below the periphery of the preceding turn. Outer lip thin, somewhat sinuous; basal lip almost straight; columella exceedingly short, represented by the mere upward turn of the basal lip; parietal wall covered by a thin callus.

The type has almost five whorls and measures: Altitude, 1.5 mm.; greater diameter, 5 mm.; lesser diameter, 4.4 mm. The type and seven specimens, Cat. No. 192981, U.S.N.M., were collected by Maj. E. A. Mearns in Lake Buluan, Rio Grande Valley, Mindanao.

The only other *Helicorbis* reported from the islands is *P.* (*H.*) *luzonicus* Möllendorff. The much larger size —altitude, 3 mm.; greater diameter, 10.5 mm.; lesser diameter, 9 mm. —is sufficient to distinguish it from the present species.

A REVIEW OF THE MULLIDÆ, SURMULLETS, OR GOATFISHES OF THE SHORES OF JAPAN.

By JOHN OTTERBEIN SNYDER,
Assistant Professor of Zoology, Stanford University, California.

The following account of the Mullidæ of Japan is based on material collected by Messrs. Jordan and Snyder during the summer of 1900. Collections from the Philippines, Samoa, Formosa, and Hawaii have also been available. Specimens of the species collected have been deposited in the United States National Museum and in the collections of Stanford University.

One species, *Pseudupeneus ischyrus*, is described as new.

The writer wishes to express his obligations to Dr. David Starr Jordan for indispensable aid in the preparation of this paper.

Family MULLIDÆ.

Body elongate, slightly compressed; upper profile of head more or less parabolic; mouth small, low, subterminal; eye moderate, placed high; premaxillaries somewhat protractile, maxillaries thin, nearly as broad at base as at tip, without supplemental bone, partly hidden by the broad preorbital; teeth mostly small, variously placed; no canines, incisors, nor molars; branchiostegals 4; pseudobranchiæ present; throat with 2 long unbranched barbels attached just behind the symphysis of the lower jaw. According to Starks these barbels are suspended from the tip of a slender, nearly straight ray of bone attached to the end of the ceratohyal. Barbels, apparently similar, appear also in the *Polynemidida*, but in that family the structures are, according to the same investigator, wholly different in character. Preopercle entire or slightly serrate; opercle unarmed or with a single spine. Body covered with large scales which are usually slightly ctenoid; head with large scales; lateral line continuous, the pores often branched. Dorsal fins 2, remote from each other, both short, the first of 6 or 8 rather high spines which are depressible in a groove; anal short, similar to the soft dorsal; ventrals thoracic I, 5. Air-bladder usually present, simple. Vertebræ 9+14. Stomach siphonal.

Natives of tropical seas, some species extending northward. Many of the species are highly valued as food.

The Japanese species are known as "Benisashi" (red-smear), or as "Higoi" (fire carp), or "Umihigoi" (sea red carp).

KEY TO GENERA.

a. Vomer and palatines without teeth.
  b. Teeth of jaws rather strong, in one or two series ..... *Pseudupeneus*, 1
  bb. Teeth of jaws small, subequal, in several series or in villiform bands ..... *Mulloides*, 2
aa. Vomer and palatines with teeth; teeth of jaws small, mostly in villiform bands ..... *Upeneus*, 3

1. PSEUDUPENEUS Bleeker.

Upeneus[a] Cuvier, Règne Animal, 2d ed., 1829, II, p. 157, in part (*vittatus; russellii; bifasciatus; trifasciatus*); (restricted by Bleeker to *bifasciatus*).

Hypeneus Agassiz, Nom. Zoöl., Index Universalis, 1846, p. 190 (amended orthography).

Pseudupeneus Bleeker, Poiss. Côte de Guinée, 1862, p. 56 (*prayensis*); (teeth biserial above, uniserial below).

Parupeneus Bleeker, Notice sur le *Parupeneus bifasciatus* de l'Ile la Réunion, 1867, p. 345 (*bifasciatus*); (teeth uniserial, conic, in both jaws).

Mullhypeneus Poey, Synopsis, 1868, p. 307 (*maculatus*); (teeth partly biserial above, uniserial below).

Brachymullus Bleeker, Archiv Neerl., XI, 1875, p. 333 (*tetraspilus*); (teeth in both jaws, biserial in front).

Eye large, high, posterior; opercle short, deep, with a posterior spine; jaws with one or two series of rather strong, unequal teeth; no teeth on vomer or palatines; barbels nearly as long as head; head and body with very large, somewhat ctenoid scales; lateral line continuous, its tubes branched on each scale; first dorsal with 8 spines; caudal forked. Species numerous in the tropical seas.

All the Japanese species belong to the section, *Parupeneus*, having the teeth strictly uniserial in both jaws.

(*ψευδής*, false; *upeneus.*)

KEY TO SPECIES.

a. Gillrakers numerous, about 6 + 23 on first arch; caudal peduncle with a dusky saddle; scales 30.
  b. Soft dorsal and anal with posterior rays produced or filamentous; body with three dark crossbands ..... *moana*, 1
  bb. Soft dorsal and anal without filamentous rays.

[a] The name *Upeneus* was first restricted by Bleeker to the species which, like *bifasciatus*, have the teeth in both jaws, conic and uniserial; those with teeth on jaws, vomer and palatines also, being called *Upeneoides*. But as *Upeneoides vittatus* is the first species mentioned under *Upeneus* by Cuvier, Bleeker afterwards transferred the name *Upeneus* to this group, giving the new name, *Parupeneus*, to *Upeneus bifasciatus*. *Vittatus* stands as *chef de file* or type in the arrangement of Cuvier and Valenciennes. It should therefore, in my judgment, remain the type of *Upeneus*, as in Bleeker's later papers.—Jordan.

c. Side of body with a single dark stripe.....*ischyrus*, 2
cc. Side of body with 3 dark stripes; 2 dark spots behind eye.....*spilurus*, 3
aa. Gillrakers comparatively few, about 6+17; caudal peduncle without dusky saddle; scales 30.
d. Caudal peduncle with a round, black spot.
e. Spinous dorsal high, reaching beyond origin of soft dorsal when depressed; sides with a dusky stripe; scales bordered with black.....*barberinus*, 4
ee. Spinous dorsal low, not nearly reaching base of soft dorsal when depressed; no dusky lateral stripe; scales plain; a yellowish spot on laterial line between dorsal fins.....*indicus*, 5
dd. Caudal peduncle without black spot; each scale with a dark spot.
f. Sides with a golden lateral stripe; a brownish spot behind eye and another above axil.....*chrysopleuron*, 6
ff. Sides without lateral stripe; a black spot below lateral line under spinous dorsal; cheeks and snout with bluish stripes.....*pleurospilos*, 7

1. PSEUDUPENEUS MOANA Jordan and Seale.

Upeneus trifasciatus GÜNTHER, Fische d. Südsee, I, 1873, p. 59, pl. XLIV, fig. B. U. C. (Vavau, Samoa, Amboina; not of Lacépède).—ISHIKAWA and MATSUURA, Prelim. Cat., 1897, p. 54 (Okinawa).

Pseudupeneus multifasciatus BLEEKER, Revis. Mull., 1874, p. 20, pl. IV, fig. 4 (East Indies).

Upeneus multifasciatus SEALE, Occasional Papers, Bishop Mus., I, No. 3, p. 71, 1903 (Guam; not of Quoy and Gaimard).

Pseudupeneus moana JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIX, 1905, p. 534 (Tahiti).—JORDAN and SEALE, Bull. Bureau of Fisheries, XXV, p. 274, 1905 (1906), (Samoa).

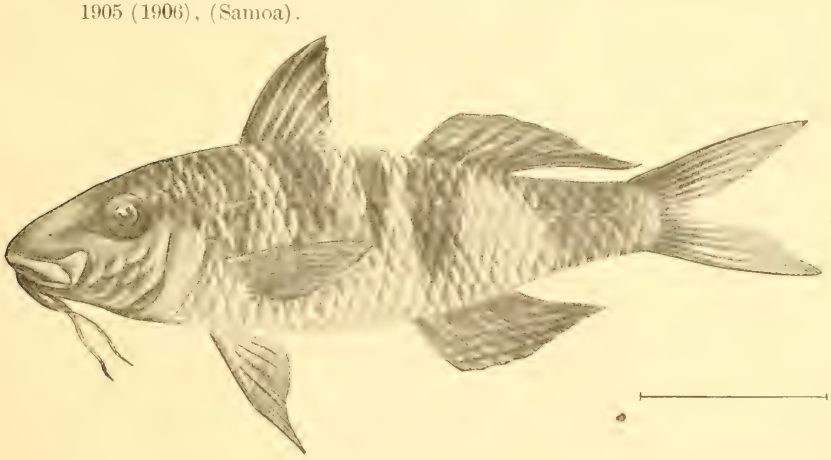


FIG. 1.—PSEUDUPENEUS MOANA.

Habitat.—South seas north to Riu Kiu islands.

Head 3 in length to base of caudal; depth $3\frac{1}{2}$; depth caudal peduncle $8\frac{1}{2}$; eye 6 in head; width interorbital space $3\frac{2}{3}$; length snout $1\frac{2}{3}$; maxillary $2\frac{1}{2}$; D. VIII–9; A. 7; scales in lateral series 30.

Snout elongate, anterior profile concave, interorbital space very convex, jaws equal. Maxillary, except small posterior portion, concealed beneath preorbital and wide upper lip. Teeth rather large, blunt, widely spaced; in a single series on both jaws, none on palatines and

vomer. Pseudobranchiæ large; gillrakers 7+28, long and slender. Peritoneum silvery. Barbels extending posteriorly to a point below tip of opercular spine Scales weakly ctenoid; head completely scaled, the scales of snout and jaws deeply embedded, usually invisible; 2 rows of scales above lateral line, 5 between lateral line and base of anal. First dorsal spine minute, the third longest, $1\frac{3}{5}$ in head. Height of soft dorsal about 3 in head; last ray elongate, reaching base of caudal. Anal equal to dorsal in height, the last ray elongate but not quite reaching base of caudal. Caudal forked, the lobes obtusely pointed, $1\frac{1}{4}$ in head. Ventrals pointed, nearly reaching vent. Pectorals, $1\frac{1}{2}$ in head.

Color in alcohol, dusky; 4 dark, saddle-shaped bars across back and extending downward below lateral line; the first rather faint, below middle of base of spinous dorsal two faint dark shades before this; the second a little more definite, between dorsals; the third below anterior part of soft dorsal, the fourth on caudal peduncle; a light yellowish band between the last 2 dark ones; spinous dorsal dusky; soft dorsal blackish anteriorly and posteriorly, the lighter parts with narrow dusky stripes; anal with narrow dusky stripes, those nearer edge of fin more prominent; anterior portions of ventrals dusky.

Described from a Samoan specimen 220 mm. long.

Color in life dusky, purplish red, with 4 darker crossbands; dorsals clouded with dusky; second dorsal with blue and yellow streaks at tip; caudal dark brown, edged with black above and below; anal pale violet, with 4 violet and 4 light yellow streaks; ventral red, with a purple black edge; pectoral bright golden orange.

This species, common in the East Indies and in the South Seas, seems never to have received a distinctive name. The name *trifasciatus* certainly belongs to *Pseudupeneus bifasciatus*, while that of *multifasciatus* was given to the common moana of the Hawaiian Islands.—JORDAN.

(*moana*, Samoan name, meaning the sea.)

2. **PSEUDUPENEUS ISCHYRUS** Snyder, new species.

Habitat.—Bay of Tokyo.

Head $3\frac{1}{5}$ in length to base of caudal; depth $2\frac{9}{10}$; depth of caudal peduncle $7\frac{2}{5}$; eye $4\frac{1}{2}$ in head; width interorbital space $3\frac{2}{5}$; length snout 2; maxillary 3; D. VIII–9; A. 7; scales in lateral line 28.

Body notably deep, dorsal outline gently sloping from snout to spinous dorsal. Eye located nearer border of opercle than tip of snout, a distance equal to half the diameter of orbit. Interorbital area very convex. Snout pointed; jaws equal; lips broad; maxillary concealed for the greater part of its length by upper lip and overhanging preorbital, not nearly reaching a vertical through anterior edge of orbit. Teeth on jaws a single row of small, widely spaced, blunt canines; palatines and vomer without teeth. Pseudobranchiæ large; gillrakers 6+23, long, slender, flattened toward their bases. Peritoneum light. Barbels extending posteriorly to edge of preopercle.

Preopercle smooth; opercle with a small, flat spine at angle. Head completely scaled, the scales of snout, maxillary, and chin deeply embedded; scales of body weakly ctenoid; 2 rows above lateral line, 6 between lateral line and insertion of anal; dorsal and anal naked; small scales on caudal. Pores of lateral line with 5 or 6 branches. First dorsal spine minute and closely adnate to second; the third longest, $1\frac{3}{5}$ in head. Height of soft dorsal equal to that of anal, $2\frac{1}{10}$ in head. Caudal deeply forked, the lobes pointed, about equal in length to head. Pectorals and ventrals extending an equal distance posteriorly, their length $1\frac{1}{3}$ in head.

Color in spirits dark brownish; an indefinitely defined dark stripe extending from snout through eye, along lateral line at least to end of spinous dorsal; a narrow light stripe below the dark one; a dusky saddle across caudal peduncle.

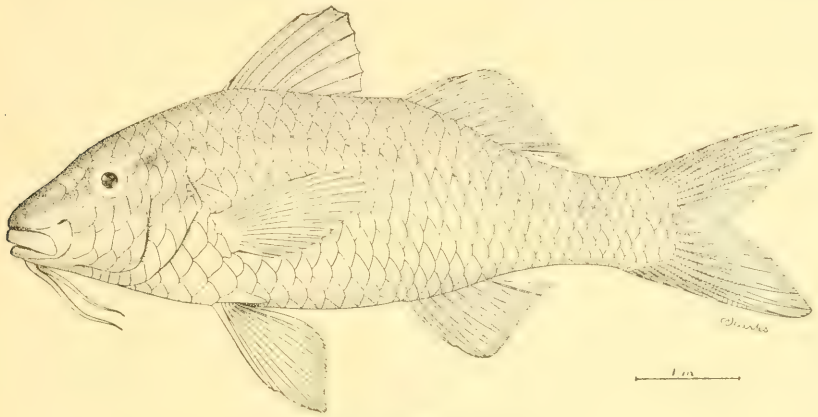


FIG. 2.—PSEUDUPENEUS ISCHYRUS.

The species is represented by the type only, a poorly preserved specimen from Tokyo, No. 9790, Stanford University collection. Length, 195 mm.

This species is closely related to *Pseudupeneus signatus* (Günther). It seems to differ in having a much deeper caudal peduncle and a smaller eye, distinguishing characters which appear at once when the specimen is compared with one of *P. signatus* from Lord Howe Island.

(*ἰσχυρός*, robust.)

3. PSEUDUPENEUS SPILURUS (Bleeker).

Upeneus spilurus BLEEKER, Fauna Ichth. Jap., 1854, p. 395 (Nagasaki); Verh. Bat. Gen., XXVI, 1854, p. 68, pl. II, fig. 2 (Japan).—JORDAN and SNYDER, Prelim. Check List, 1901, p. 84.—GÜNTHER, Cat. Fishes, I, 1859, p. 406 (copied).

Habitat.—Southern Japan.

Head $3\frac{1}{5}$ in length to base of caudal; depth 3; depth of caudal peduncle 8; eye $5\frac{1}{2}$ in head; width interorbital space 3; length snout 2; maxillary $2\frac{3}{5}$; D. VIII–9; A. 7; scales in lateral line 29.

Body deep, the dorsal contour strongly arched; snout long, pointed, its dorsal outline concave. Interorbital space very convex, occasionally somewhat flattened. Lower jaw slightly shorter than upper; lips very broad, the upper partly covering anterior half of maxillary. Maxillary fleshy, the greater part of upper edge covered by preorbital. Barbels extending to a vertical midway between edges of opercle and preopercle. No teeth on vomer and palatines; a single row of widely spaced, blunt canines on jaws. Pseudobranchiæ large. Gillrakers 6+23, slender, the longest equal to diameter of eye. Air bladder large. Peritoneum silvery. Preopercle smooth; opercle with a large, flat spine at upper angle. Head completely scaled, the scales of snout, maxillary, and chin deeply embedded, sometimes not visible; scales weakly etenoid; 2 rows above lateral line, 6 between lateral line and origin of anal; small scales on caudal; soft dorsal and anal naked. Pores of lateral line apparently single or with 3 or 4 branches on anterior scales; with many minute branches on posterior ones. First dorsal spine very short and closely adnate to second; third and fourth spines longest, $1\frac{3}{5}$ in head, reaching beyond tips of other spines in closed fin. Height of longest, (third or fourth) dorsal ray $1\frac{1}{2}$ in head; anal slightly lower than soft dorsal; caudal deeply cleft, the lobes pointed, $1\frac{1}{5}$ in head; pectorals and ventrals pointed, about $1\frac{2}{5}$ in head.

Color in life bright carmine red, with 3 curved stripes, olive in color with a brassy sheen, extending from tip of snout to below end of soft dorsal fin, the median stripe passing through eye and along lateral line; caudal peduncle with a blackish saddle, the lower portions of which are often darker, forming on each side a round black spot; 2 round dusky spots behind eye; fins pink, the pectorals and spinous dorsal darker than others; ventrals with indistinct basal and subterminal dark bands. In spirits the bright colors entirely disappear, leaving 3 indistinct, dusky lateral stripes on the sides, and a dark saddle across the caudal peduncle. Some examples are less brightly colored. Length about 300 mm. Southern Japan, rare. Our specimens are from Wakanoura and Nagasaki.

(*σπίλος*, spot; *οὐρά*, tail.)

4. PSEUDUPENEUS BARBERINUS (Lacépède.)

Mullus barberinus LACÉPÈDE, Hist. Nat. Poiss., III, 1802, p. 406, pl. XIII, fig. 3 (Straits of Bouton).

Upeneus barberinus CUVIER and VALENCIENNES, Hist. Nat. Poiss., III, 1829, p. 642 (copied).—RÜPPELL, N. W. Fische, 1837, p. 101 (Red Sea).—GÜNTHER, Cat. Fishes, 1, 1859, p. 405 (Moluccas, Amboyna, India); Fische d. Sudsee, I, 1873, p. 57, pl. XLII (Palau, Paumoto, Tahiti, Samoa, Kingsmill, Solomon Island).—KNER, Novara, Fische, 1865, p. 70.—KLUNZINGER, Fische d. roth. Meer, 1870, p. 745 (Red Sea).—DAY, Fishes India, 1878, p. 124.—JORDAN and SNYDER, Prelim. Check List, 1901, p. 84.

Parupeneus barberinus BLEEKER, Ternate, p. 234 (East Indies); Revis. Mull., 1874, p. 25.

Pseudupeneus barberinus JORDAN and SEALE, Proc. U. S. Nat. Mus., XXVIII, 1905, p. 782 (Negros); Fishes Luzon and Panay, Bull. Bureau of Fisheries, XXVI, p 25, 1906 (1907), (Iloilo); Fishes Samoa, Bull. Bureau of Fisheries, XXV, p. 276, 1905 (1906), (Apia).

Habitat.—East Indies and South Seas, north to Riu Kiu Islands.

Head 3 in length to base of caudal; depth 3½; depth of caudal peduncle 8½; eye 6½ in head; width interorbital space 4⅔; length snout 1¾; maxillary 3⅙; D. VIII–9; A. 7; scales in lateral line 30.

Snout notably long, its upper contour concave; interorbital space convex; eye nearer edge of opercle than tip of snout, a distance equal to twice the vertical diameter of orbit. Jaws equal; upper edge of maxillary sheathed by preorbital; posterior edge convex. Teeth rather large, widely spaced, in a single series on jaws; none on vomer or palatines. Pseudobranchiæ large; gillrakers 7+17; long, slender, and sharply pointed. Peritoneum dusky. Barbels extending to edge of preopercle. Opercular spine flat and blunt; preopercle smooth. Scales ctenoid; those of snout, maxillary, and lower jaw deeply embedded; 3 rows above lateral line, 6 between lateral line and base of anal; pores of lateral line with 10 or 12 branches. Spinous dorsal high, reaching to base of third dorsal ray when depressed; first spine very short; the third longest, 1⅓ in head; eighth, 6⅔ in head. Soft dorsal and anal equal in height, 2⅔ in head. Caudal lobes acute, 1⅓ in head; pectoral, 1⅘; ventral, 1½.

Color in spirits brownish, each scale with a dark edge; a dark stripe extending from upper edge of opercle backward to end of soft dorsal; a round, blackish spot near base of caudal.

This species is abundant in the East Indies and in the South Seas north to the Riu Kiu Islands.

According to Doctor Jordan, the life colors are as follows:

Reddish gray with bluish and yellowish streaks on head, the scales edged with bronze; a blackish brown stripe from snout through eye to last dorsal rays; a large, dark brown spot at base of caudal; barbels white. Dorsal reddish, edged with brown in front; second dorsal and anal with obscure, yellowish cross-streaks; caudal reddish, the rays yellowish; ventrals and pectorals pale, tinged with yellowish.

This species is abundant in the East Indies and in the South Seas north to the Riu Kiu Islands. It is here described from Samoan specimens.

(Name unexplained; perhaps for Barberini.)

5. PSEUDUPENEUS INDICUS (Shaw).

Mullus indicus SHAW, Genl. Zool., IV, 1803, Pt. 2, p. 416 (Vizagapatam; after *Rahtee goolivinda* of Russell).

Upeneus indicus GÜNTHER, Cat. Fishes, I, 1859, p. 406 (China); Fische d. Sudsee, I, 1873, p. 57 (Samoa).—DAY, Fishes Malabar, 1865, p. 28 (Malabar); Fishes India, 1878, p. 126, pl. XXXI, fig. 4 (India).—ISHIKAWA and MATSUURA, Prelim. Cat., 1897, p. 54 (Riu Kiu).—JORDAN and SNYDER, Prelim. Check List,

1901, p. 84 (Nagasaki).—JORDAN and EVERMANN, Proc. U. S. Nat. Mus., XXV, 1902, p. 334 (Keerun, Giran).

Pseudupeneus indicus JORDAN and SEALE, Fishes Luzon and Panay, Bull. Bureau of Fisheries, XXVI, p. 25, 1906 (1907), (Iloilo); Fishes Samoa, Bull. Bureau of Fisheries, XXV, p. 276, 1905 (1906), (Apia).

Parupeneus indicus BLEEKER, Bouro, p. 148; Revis. Mull., 1874, p. 27.

Upeneus russellii CUVIER and VALENCIENNES, Hist. Nat. Poiss., III, 1829, p. 465, (after Russell).—RICHARDSON, Ichth. China, 1846, p. 220 (Canton).—BLEEKER, Percoiden, 1849, p. 62 (East Indies).

Upeneus waigiensis CUVIER and VALENCIENNES, Hist. Nat. Poiss., III, 1829, p. 446 (Waigiu).

Upeneus malabaricus CUVIER and VALENCIENNES, Hist. Nat. Poiss., III, 1829. p. 467 (Malabar).—GÜNTHER, Cat. Fishes, I, 1859, p. 407 (Philippines); Fische d. Sudsee, I, 1873, p. 58, pl. XLV, fig. B (Formosa, Philippines, Zanzibar, Savaii, Tonga).

Mullus malabaricus PLAYFAIR, Fish. Zanz., p. 41 (Zanzibar).

Upeneus griseofrenatus KNER. Sitz. Wien. Akad., 1868, XVIII, p. 305, pl. III, fig. 7 (Fiji).

Habitat.—South Seas and India, north to Riu Kiu Islands.

Head $3\frac{1}{4}$ in length; depth $3\frac{1}{5}$; depth caudal peduncle $7\frac{1}{4}$; eye $4\frac{1}{2}$ in head; width interorbital space $3\frac{1}{5}$; length snout $2\frac{1}{10}$; maxillary $3\frac{1}{10}$; D. VIII–9; A. 7; scales in lateral line 30.

Interorbital space convex; snout short; eye located nearer border of opercle than tip of snout, a distance equal to $\frac{2}{3}$ its diameter. Edge of maxillary covered by preorbital sheath; jaws equal. Teeth of jaws in a single row, widely spaced, rather blunt; vomer and palatines smooth. Pseudobranchiæ large; gillrakers, 6+17, rather long and slender. Peritoneum dusky. Barbels extending a little beyond edge of preopercle. Opercular spine flat and sharp. Scales ctenoid, those of snout, maxillary, and jaw not concealed beneath thick skin; 3 rows above lateral line, 5 between lateral line and base of anal fin. Pores of lateral line with 5 or 6 branches. First dorsal spine minute, the third longest, $1\frac{3}{5}$ in head; depressed fin not nearly reaching base of soft dorsal. Soft dorsal and anal of equal height, $2\frac{1}{6}$ in head. Caudal equal in length to head. Pectoral, $1\frac{1}{3}$ in head; ventral, $1\frac{1}{3}$.

Alcoholic specimens have a light spot on lateral line between the dorsal fins, and a black spot on upper middle portion of caudal peduncle.

The species is here described from a Formosan specimen about 155 mm. long. Doctor Jordan thus describes the colors of a living example from Apia:

> Olive green, each scale with a darker edge; a large, oblong, golden-yellow blotch under soft dorsal; a large, black blotch before base of caudal; cheeks olive, with blue streaks. Dorsals olive; second dorsal faintly barred with brassy; anal pinkish, similarly barred; ventral and pectoral pinkish; caudal pale, yellowish olive, the outer rays pink; barbels pinkish.

The species is abundant in the Indies, ranging northward to the Riu Kiu Islands.

(*indicus*, Indian.)

6. PSEUDUPENEUS CHRYSOPLEURON (Temminck and Schlegel).

UMIHIGOI[a] (SEA FIRE-CARP).

Mullus chrysopleuron TEMMINCK and SCHLEGEL, Faun. Japon. Poiss., 1845, p. 29, pl. XII, fig. 1 (Nagasaki).—BLEEKER, Verh. Bat. Gen., XXV, p. 10 (Japan); XXVI, 1854, p. 70 (Japan).

Upeneus chrysopleuron GÜNTHER, Cat. Fishes, I, 1859, p. 410 (China).—JORDAN and SNYDER, Prelim. Check List, 1901, p. 84.

Upeneus biaculeatus (Gray) RICHARDSON, Ich., China, 1846, p. 219 (Canton).

(?) *Upeneus dubius* TEMMINCK and SCHLEGEL, Faun. Japon. Poiss., 1845, p. 30, pl. XI, fig. 3 (Nagasaki).—GÜNTHER, Cat. Fishes, I, 1859, p. 411 (copied).

Habitat.—Coasts of southern Japan and China.

Head $3\frac{1}{5}$ in length to base of caudal; depth $3\frac{1}{5}$; depth caudal peduncle $8\frac{1}{4}$; eye $4\frac{2}{3}$ in head; width interorbital space $3\frac{1}{2}$; snout $1\frac{9}{10}$; maxillary $2\frac{3}{4}$; D. VIII–9; A. 7; scales in lateral line 28.

Dorsal profile of head and body steep, the ventral outline almost straight. Snout rather blunt; jaws equal; maxillary not nearly reaching vertical through anterior edge of orbit, the greater part of its edge slipping under preorbital; lips broad. Eye located nearer edge of opercle than tip of snout, a distance equal to diameter of orbit. Teeth on jaws a single row of widely spaced, sharp canines; none on palatines or vomer. Pseudobranchiae large; gillrakers 4 + 18, long and very slender; those on upper arch preceded by 4 or 5 minute knobs. Peritoneum silvery. Barbels not quite reaching a point below border of opercle. Preopercle entire. Opercle with a small, flat sharp spine at angle. Head completely scaled, the scales of snout, maxillary, and chin deeply embedded; scales of body weakly ctenoid; 2 rows above lateral line, 5 between lateral line and origin of anal; caudal with small scales, the soft orsal and anal apparently naked. Pores of lateral line with 4 or 5 branches. First dorsal spine minute, the third longest, $1\frac{2}{3}$ in head. Height of soft dorsal and anal $1\frac{3}{10}$ in head. Caudal lobes pointed, $1\frac{1}{5}$ in head. Pectorals and ventrals pointed, $1\frac{2}{5}$ in head.

Color in life, bright red, a bright-golden stripe extending from eye to base of caudals; fins all red; barbels pale yellow. In alcoholic specimens the lateral stripe is visible, a dusky vertical line or spot appears on each scale above the stripe, and there is a brownish spot behind eye and another above axil.

Specimens 180 mm. long were collected at Wakanoura and Tokyo. The species is not very common, but being of large size is valued as food.

Individuals of this species were observed slowly swimming near the bottom of a tank, the conspicuous yellow barbels extended forward and constantly moved about as if they were organs of touch.

(*χρυσός*, gold: *πλεύρον*, side.)

[a] *Umi*, sea; *hi*, fiery-red; *koi*, carp.

7. PSEUDUPENEUS PLEUROSPILOS (Bleeker).

Upeneus pleurospilos BLEEKER, Natur. Tyds. Nederl. Ind., IV, 1853, p. 110 (Amboyna); Verh. Bat. Gen., XXVI, 1854, p. 69 (Japan).—GÜNTHER, Cat. Fishes, I, 1859, p. 407 (copied).

Habitat.—East Indies, north to Nagasaki.

D. VIII–9; A. 8; scales lateral line 30.

The height of the body is nearly equal to the length of the head, $4\frac{1}{2}$ in the total. The barbels reach to the posterior margin of the operculum. Spinous dorsal much lower than the body. Rose colored; each scale of the back and of the sides with a central reddish-violet spot; a black spot below the lateral line, corresponding to the posterior part of the spinous dorsal; cheeks and snout with bluish stripes; the second dorsal with two blue longitudinal bands; the caudal, anal, and ventral fins with yellow bands.—(Günther after Bleeker.)

This species was not seen by the writer.

(*πλεύρον*, side: *σπίλος*, spot.)

2. MULLOIDES Bleeker.

Mulloides BLEEKER, Percoiden, Sept., 1848, in Verh. Bat. Gen., XXII, 1849, (*flavolineatus*).

In this genus the teeth in both jaws are in narrow villiform bands. There are none on the vomer or palatines. Species numerous, chiefly in the Pacific Ocean.

(*mullus*, the surmullet: *εἶδος*, likeness.)

8. MULLOIDES JAPONICUS (Houttuyn).

Mullus japonicus HOUTTUYN, Mém. Harl., XX, 1782, p. 334 (Nagasaki).
Upeneus japonicus CUVIER and VALENCIENNES, Hist. Nat. Poiss., III, 1829, p. 460 (Japan).
Mulloides japonicus GÜNTHER, Cat. Fishes, I, 1859, p. 404 (copied).

Habitat.—Coasts of southern Japan.

Head $3\frac{1}{2}$ in length; depth $4\frac{2}{5}$; depth of caudal peduncle 11; eye $3\frac{1}{2}$ in head; width interorbital space $3\frac{1}{2}$; length snout $2\frac{3}{5}$; maxillary $3\frac{1}{3}$; D. VIII–9; A. 7; scales lateral line 37.

Body slender, the snout pointed. Eye slightly nearer tip of snout than border of opercle. Interorbital space not strongly convex. Jaws equal; maxillary not quite reaching vertical through anterior margin of orbit; evenly rounded posteriorly; about two-thirds of its upper edge concealed by preorbital. Teeth minute; in narrow bands on jaws; those in upper jaw in but 2 or 3 rows; vomer and palatines without teeth. Pseudobranchiæ large; gillrakers 7 + 23, long and slender. Peritoneum dusky. Barbels extending to edge of preopercle. Angle of opercle with a small, flat spine; preopercle entire. Head, including snout, maxillary, and chin, scaled; scales of body weakly ctenoid; 3 rows above lateral line, 5 rows between lateral line and base of anal; caudal with minute scales; dorsal and anal naked. Tubes of lateral

line with 3 or 4 branches. Dorsal spines very slender; the first longest, $1\frac{1}{2}$ in head; apparently not preceded by a minute, embedded spine; soft dorsal and anal of equal height, the longest ray $2\frac{1}{3}$ in head. Lobes of caudal acutely pointed, about equal to length of head. Ventrals slightly longer than pectorals, $1\frac{2}{3}$ in head.

Color in spirits brownish above, silvery below.

Two specimens, 140 mm. long, from Misaki.

This species is certainly the *japonicus* of Cuvier and Valenciennes, and it is probably also that of Houttuyn, although Houttuyn says scarcely anything about the species, and part of that is untrue.[a]

(*japonicus*, Japanese.)

3. UPENEUS Cuvier.

Upeneus Cuvier, Règne Animal, 2d ed., 1829, p. 157 (*vittatus*, etc.).

Upeneus Section I, Cuvier and Valenciennes, Hist. Nat. Poiss., III, 1829, p. 448 (*vittatus*).

Upeneoides Bleeker, Percoiden, 1849, p. 63 (*vittatus*).

Teeth in villiform bands on jaws, vomer, and palatines. Pacific Ocean.

(*upeneus*, a Latin name of some fish from ὑπήνη, upper lip.)

KEY TO SPECIES.

a. Dorsal spines VII, the first long and slender; caudal lobes barred in life; scales 36 ..... *bensasi*, 9

aa. Dorsal spines VIII, the first very short.

b. Scales small, about 36 in lateral line; anal rays 8; gillrakers about 7+18 ..... *sulphureus*, 10

bb. Scales larger, about 30 in lateral line; anal ray 7; gillrakers about 2+12.

c. Body with brown lateral stripe; spinous dorsal with a black spot .. *tragula*, 11

cc. Body plain; dorsal fins narrowly edged with dusky ..... *subrittatus*, 12

9. UPENEUS BENSASI (Temminck and Schlegel).

BENISASHI (RED-SMEAR).

Mullus bensasi Temminck and Schlegel, Faun. Japan. Poiss., 1845, p. 30, pl. xi, fig. 2 (Nagasaki).

Upeneoides bensasi Bleeker, Verh. Bat. Gen., XXVI, 1854, p. 71 (Nagasaki).—Günther, Cat. Fishes, I, 1859, p. 399 (copied).— (?) Day, Fishes India, 1878, p. 121, pl. xxx, fig. 5 (Madras, Coromandel).—Ishikawa and Matsuüra, Prelim. Cat., 1897, p. 54 (Tokyo).

Upeneoides japonicus Steindachner and Döderlein, Fisch. Jap., II, 1883, p. 22 (Oshima, Kochi, Tokyo, Tango).—Jordan and Snyder, Proc. U. S. Nat. Mus., XXIII, 1900, p. 358 (Tokyo); Prelim. Check List, 1901, p. 83 (Yokohama). (Not *Mullus japonicus* Houttuyn.)

Upeneoides tokisensis Steindachner and Döderlein, Fisch. Jap., II, 1883, p. 22 (Tokyo).

[a] D. VII–9. Caudal forked; mouth toothless; color more yellow than red; length 6 inches.

Habitat.—Coasts of Japan, southward.

Head $3\frac{1}{3}$ in length to base of caudal; depth 4; depth caudal peduncle 10; eye 4 in head; width interorbital space $3\frac{1}{2}$; length snout $2\frac{2}{3}$; maxillary $2\frac{2}{3}$; D. VII–9; A. 7; scales in lateral series 30.

Eye located midway between tip of snout and opercle, its upper edge almost on a line with dorsal contour of head. Interorbital space somewhat convex, the width equal to or greater than diameter of eye, the proportions differing with age. Lower jaw included; maxillary equal in length to snout, extending to a point below anterior margin of eye, its upper edge, except at tip, covered by preorbital. Teeth villiform, in bands on jaws, vomer, and palatines; premaxillary band broadening posteriorly, then narrowing and growing sharply pointed at the ends; mandibular band gradually narrowing from before backward. Pseudobranchiæ large; gillrakers, 4+13, slender, the longest about equal to diameter of pupil; those on upper arch preceded by 4 small knobs. Air bladder present. Cæca 15. Peritoneum, black.

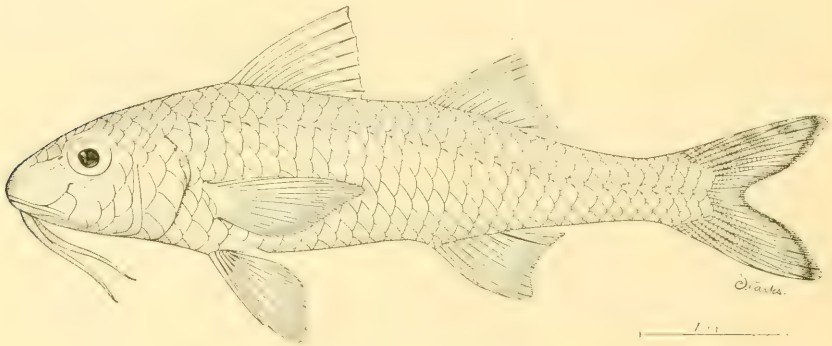


FIG. 3.—UPENEUS BENSASI.

Barbels extending posteriorly almost to end of opercle. Edge of preopercle, smooth; opercle with a weak, somewhat rounded spine at its angle. Scales, weakly ctenoid; head, including snout, maxillary, chin, and throat, scaled; soft dorsal, anal, and caudal with small scales; 2 rows between lateral line and spinous dorsal; 6 rows between lateral line and anal. Tubes of lateral line with 4 or 5 branches. First dorsal spine longest, in most examples reaching beyond tips of others when fin is depressed, $1\frac{1}{3}$ in head, apparently not preceded by a minute, embedded spine; membrane of fin extending to tips of spines. First dorsal ray simple; the second longest, $1\frac{3}{4}$ in head. Anal inserted below second dorsal ray, its height about $2\frac{1}{2}$ in head. Pectorals and ventrals pointed, extending an equal distance posteriorly; pectoral $1\frac{1}{4}$ in head; ventral $1\frac{1}{2}$. Caudal deeply forked $1\frac{1}{3}$ in head.

Color in life rosy, with faint yellowish lines; fins barred with orange red; dorsals and upper lobe of caudal with oblique, reddish-brown bands, the interspaces pearly, the lower lobe of caudal mostly

brick red; lower fins pale. In spirits all traces of the life color disappear, the specimens becoming brownish above and silvery below. An occasional example has the caudal narrowly tipped with dusky, and the upper lobe indistinctly barred. Length about 170 mm.

Described from specimens obtained in the market at Wakanoura, where it was the smallest and commonest representative of the family. Taken also at Nagasaki and Tokyo. In the specimen figured, the dorsal markings are faded.

(Japanese, *beni*, red; *sashi*, a smear or daub.)

10. UPENEUS SULPHUREUS Cuvier and Valenciennes.

Upeneus sulphureus Cuvier and Valenciennes, Hist. Nat. Poiss., III, 1829, p. 450 (Antjer).—Bleeker, Revis. Mull., 1874, p. 4 (Batavia).—Jordan and Seale, Fishes Philippines MS. (Cavite).

Upeneus bivittatus Cuvier and Valenciennes, Hist. Nat. Poiss., VII, 1831 (Coromandel).

Upeneoides sulphureus Bleeker, Act. Soc. Nederl., II, Amboina, 1857, p. 45 (Amboyna).—Günther, Cat. Fishes, I, 1859, p. 398 (Red Sea, Amboyna, China, New Hebrides).—Kner, Novara Fische, 1865, p. 67.—Day, Fishes India, 1878, p. 120, pl. xxx, fig. 3 (India).—Steindachner and Döderlein, Fisch. Jap., II, 1883, p. 23 (Nagasaki).—Jordan and Snyder, Prelim. Check List, 1901, p. 84.

Upeneoides fasciolatus Day, Proc. Zool. Soc., 1868, p. 151 (India.)

Upeneus pinnifasciatus Steindachner, Ich. Not., X, 1870, p. 2 (Nagasaki).

Habitat.—East Indies, north to Nagasaki.

Head $3\frac{2}{5}$ in length to base of caudal; depth $3\frac{2}{5}$; depth caudal peduncle $8\frac{3}{4}$; eye $3\frac{3}{4}$ in head; width interorbital space $3\frac{3}{4}$; length snout $2\frac{1}{3}$; maxillary $2\frac{2}{5}$; D. VIII–9; A, 8; scales in lateral line 36.

Snout rather short; anterior profile steep; eye located high in head, midway between tip of snout and border of opercle; interorbital space only slightly convex. Lower jaw shorter than upper; maxillary extending to below center of pupil, broad and rounded posteriorly, the upper edge slipping under preorbital. Teeth in villiform bands on jaws, vomer, and palatines. Pseudobranchiæ large; gillrakers, 7+18, long and very slender. Barbels extending to a vertical passing midway between edge of preopercle and opercle. Preopercle smooth; opercle with but a trace of a spine at angle; scales ctenoid; head completely scaled; 3 rows between lateral line and dorsal, 6 between lateral line and anal; dorsal, anal, and caudal with minute scales; pores of lateral line with 4 to 6 branches. First dorsal spine minute, the second longest, $1\frac{1}{3}$ in head; dorsal and anal of equal height, 2 in head; caudal $1\frac{1}{3}$; pectoral, $1\frac{1}{4}$; ventral, $1\frac{3}{4}$.

Color in spirits, brownish above, yellowish below; upper parts with traces of narrow, yellow stripes; spinous dorsal with 3 horizontal stripes, the upper one terminal and dense black; soft dorsal and caudal edged with dusky.

Described from a specimen measuring 130 mm., from Samoa.

It was not seen by us in Japan, but it is recorded by Steindachner from Nagasaki.

(*sulphureus*, sulphur-yellow.)

11. UPENEUS TRAGULA Richardson.

Upeneus tragula Richardson, Ichth. China, 1846, p. 220 (Canton).—Jordan and Seale, Proc. U. S. Nat. Mus., XXVIII, 1905, p. 782 (Negros).—Jordan and Seale, Fishes Philippines MS. (Manila, Cavite, Iloilo, Panay).

Upeneoides tragula Günther, Cat. Fishes, I, 1859, p. 398 (Amboyna, Philippines, Canton).—Kner, Novara, Fische, 1837, p. 66.—Day, Fishes India, 1878, p. 121, pl. xxx, fig. 4 (India, Andaman Is.).—Steindachner and Döderlein, Fische Jap., II, 1883, p. 22 (Kagoshima).—Jordan and Evermann, Bull. U. S. Nat. Mus., XXV, 1902, p. 335 (Keerun, Giran, Formosa, Hokoto).

Mullus tragula Playfair, Fish. Zanzibar, p. 40 (Zanzibar).

Upeneoides variegatus Bleeker, Percoiden, 1849, p. 64; Act. Soc. Nederl, II, Amboina, 1857, p. 48 (Amboyna).

Upeneoides kiusiuana Steindachner and Döderlein, Fisch. Jap., II, 1883, p. 22 (Kagoshima).

Habitat.—East Indies, north to southern Japan.

Head $3\frac{1}{2}$ in length to base of caudal; depth 4; depth caudal peduncle 9; eye 4 in head; width interorbital space 4; length snout $2\frac{2}{5}$; maxillary, $2\frac{1}{2}$; D. VIII–9; A. 7; scales lateral line 30.

Snout rather long and pointed; the anterior profile not steep, but gently sloping from snout to dorsal fin; interorbital space flat or slightly concave. Eye located high in head, midway between tip of snout and edge of opercle. Lower jaw somewhat shorter than the upper; maxillary extending to anterior edge of pupil, rounded posteriorly the entire upper edge sheathed by preorbital. Teeth villiform; in broad bands on jaws, vomer and palatines. Pseudobranchiæ large; gillrakers, 2+12, rather long and slender, those of upper row preceded by 5 rounded knobs; the lower ones followed by 4 or 5 similar elevations. Peritoneum silvery. Cœca 11. Air-bladder large. Barbel not extending quite as far posteriorly as preopercle. Opercle with a weak, flat spine at angle. Scales ctenoid; head, including snout, maxillary and chin completely scaled; 2 rows between dorsals and lateral line, 5 between anal and lateral line. Pores of lateral line with many branches. First dorsal spine minute, the second longest, $1\frac{2}{5}$ in head. Soft dorsal and anal of equal height, $1\frac{2}{3}$ in head. Caudal equal in length to head. Pectorals $1\frac{1}{2}$, ventrals $1\frac{1}{3}$ in head.

Color in spirits brown above, light below; a brown stripe extending from snout, through eye along side of body to base of caudal, above which is an indistinct light stripe; dorsals clouded with dusky, a large, black, subterminal spot of irregular outline on spinous dorsal; caudal lobes with 4 or 5 oblique, dark bars, those on the lower lobe broader; pectorals, ventrals, and anal with dusky spots or bars.

Described from Formosan specimens about 230 mm. long.

This species is common in the South Seas, and it has been once recorded from Kagoshima, in Kiushu.

(*tragula*, a dart or javelin.)

12. UPENEUS SUBVITTATUS Temminck and Schlegel).

Mullus subvittatus Temminck and Schlegel, Fauna Japon. Poiss., 1845, p. 30 (Nagasaki).—Richardson, Ichth. China, 1846, p. 219 (Canton).

Upeneoides subvittatus Jordan and Snyder, Prelim. Check List, 1901, p. 83.

Habitat.—Southern Japan and China.

Head 3⅔ in length to base of caudal; depth 4¼; depth of caudal peduncle 10½; eye 6 in head; width interorbital space 3¼; length snout 2½; maxillary 2⅗; D. VIII–9; A. 7; scales in lateral line 30.

The eye is situated lower, the interorbital space is more convex, the dorsal outline of head nearer horizontal, and the lower jaw longer than in *U. bensasi*. Eye midway between tip of snout and border of opercle. Jaws equal; maxillary extending to a point below anterior edge of pupil, the posterior edge broad, rounded and not sheathed by preorbital. Teeth villiform, in bands on jaws, vomer, and palatines. Pseudobranchiæ large; gillrakers 1+12, short, flat, and stout, the one on upper arch preceded by 5 broad knobs. Air-bladder large. Peritoneum silvery. Cœca apparently 5. Barbels extending posteriorly to edge of preopercle. Preopercle smooth; opercle with a broad, very flat spine at angle. Head, including snout, maxillary, throat and chin completely scaled; scales of body weakly ctenoid; 2 rows between lateral line and dorsals, 6 between lateral line and anal; soft dorsal, anal, and caudal with fine scales. Pores of lateral line with 5 or 6 branches. First dorsal spine minute, embedded; the second longest, 1⅔ in head, not extending to tips of other spines when fin is depressed. Height of soft dorsal 2⅓ in head, the first ray simple. Origin of anal below third or fourth dorsal ray, its height equal to that of soft dorsal. Caudal deeply notched, the lobes acutely pointed, the upper longer, 1⅓ in head. Pectorals and ventrals extending an equal distance posteriorly, 1⅔ in head.

Color in spirits dusky above, light below; dorsal fins edged with dusky; caudal with 6 oblique, dusky bars, those on lower lobe the more prominent. Belly probably silvery in life.

We have one specimen of this rare species measuring 175 mm. in length, from Wakanoura. It is otherwise recorded from Nagasaki and from Canton.

U. vittatus differs from this species in having smaller scales (35), a shorter snout, a narrow yellow stripe along side of body, and a conspicuous, broad, subterminal black band on lower lobe of caudal. Belly sulphur yellow in life.

U. arge of the Hawaiian Islands, a form resembling *U. subvittatus*, especially in having a barred caudal, differs in the smaller scales (40) and shorter and more rounded snout. In this species the belly is silvery.

(*subvittatus*, partly striped.)

SUMMARY.

Family MULLIDÆ.

1. Pseudupeneus Bleeker, 1862.

1. *moana* Jordan and Seale, 1906.
2. *ischyrus* Snyder, 1906, Tokyo.
3. *spilurus* (Bleeker) 1854; Wakanoura, Nagasaki.
4. *barberinus* (Lacépède), 1802.
5. *indicus* (Shaw), 1803.
6. *chrysopleuron* (Temminck and Schlegel), 1845; Wakanoura, Tokyo.
7. *pleurospilos* (Bleeker), 1853.

2. Mulloides Bleeker, 1848.

8. *japonicus* (Houttuyn), 1782; Misaki.

3. Upeneus Cuvier, 1829.

9. *bensasi* Temminck and Schlegel, 1845; Tokyo, Wakanoura, Nagasaki.
10. *sulphureus* Cuvier and Valenciennes, 1829.
11. *tragula* Richardson, 1846.
12. *subvittatus* (Temminck and Schlegel), 1845; Wakanoura.

A REVIEW OF THE BATS OF THE GENUS HEMIDERMA.

By Walter L. Hahn,
Fellow in Indiana University, Bloomington, Indiana.

Apparently the first published account of bats which can be definitely referred to this genus is that given by Albert Seba in his Locupletissimus rerum naturalium Thesaurus published in Amsterdam in 1734. His description, under the name of *Vespertilio americanus vulgaris*, might be applicable to any one of a number of species of leaf-nose bats, and, indeed, was supposed for more than a century to refer to a species of another genus; but fortunately his original specimens are still preserved in the British Museum[a] and their accurate identification is possible.

Seba's name is not binomial and has no standing at present in zoological nomenclature, but his description and figure were the basis for the Linnean species, *Vespertilio perspicillatus*, and hence the rediscovery of the original specimens is of very great importance.

DISTRIBUTION.

Bats of the genus *Hemiderma* are found in practically all parts of tropical and subtropical America, including the West Indies. They seem to be rare in these islands, as the extensive collections of West Indian bats in the United States National Museum contain no representatives of the genus. Three specimens from the island of Redonda are in the collections of the Academy of Natural Sciences of Philadelphia, and the only additional records of which I have any knowledge are those given by Dobson for Grenada and Jamaica. The most southern locality of which I have any record is Sapucay in central Paraguay, and the most northern is the State of Colima on the west coast of Mexico. Throughout most of this immense area some form of the genus appears to be one of the most common bats, and there are few local lists that do not record it.

[a] Thomas, Proc. Zool. Soc., Lond., 1892, p. 309.

HABITS.

In common with most other bats the habits of the *Hemidermas* are not well known. Charles Darwin writing of *H. perspicillatum*[a] says: "On entering an old limekiln in the middle of the day I disturbed a considerable number of them; they did not seem to be much incommoded by the light, and their habitation was much less dark than that usually frequented by these animals." The eaves of houses and attics are not infrequently chosen as roosting places, though caves and hollow trees are also utilized. A collector who obtained some of these bats for the U. S. National Museum in northern Ecuador has recorded on his labels that some of the specimens were taken "under stones in the ditch." Another collector smoked more than a hundred bats of several species out of two hollow trees on the Tesechoacan River in Vera Cruz, and among the number were sixty-eight specimens of the form *H. p. aztecum*. Mr. E. T. Giers, who collected in Trinidad, records that these bats "roost in houses—bite animals." Whether this last observation is correct I am unable to say.

The breeding period is somewhat extended and probably lasts through half the year or even more. Messrs. Nelson and Goldman took half-grown individuals and pregnant females of *H. p. aztecum* at Tuxtepec, Mexico, on April 12 and 22, and half-grown young at the same place on October 24. In Ecuador young were taken at an elevation of 3,500 feet on March 14, while females containing small embryos and individuals three-fourths grown were taken at Trinidad on June 13. Nothing is known of the habits or breeding season of the smaller species *subrufum* and *castaneum*.

The young acquire many of the adult characteristics very early and measurements can not be relied upon to determine age. Measurements for a specimen from Vera Cruz (Cat. No. 123764, U.S.N.M.), which appears to be only a few days old, are as follows: Hind foot, 13 mm.; forearm, 37; tibia, 17; ear, 18; nose-leaf, 7; thumb, 12. The milk-dentition is just coming into place in the upper jaw, while in the lower jaw none of the teeth have cut the gum, though the canines and first premolars are visible through it.

VARIATION.

The variations within the several species of the genus are considerable and affect practically all of the characters. Color variations are so great as to almost exclude the value of color for specific determination. In one form (*H. p. aztecum*) the color ranges from dull sooty black to a bright ferruginous. In the other forms the observed variations are not quite so great. Considerable variation is also found

[a] Under the name of *Phyllostoma grayi* Waterhouse, Mammalia of the Voyage of the *Beagle*, 1839, p. 3.

in cranial and dental characters. Two skulls from Maranhão, Brazil (Cat. Nos. 104575 and 104578, U.S.N.M.), differ so much in size and proportions that I should be inclined to regard them as belonging to different species if there were not intermediate specimens which bridge the difference.

NOMENCLATURE.

The following generic and specific names have been used:

GENERIC NAMES.

Vespertilio Linnæus, Syst. Nat., 10th ed., p. 31. Linnæus included *perspicillatum* in the genus *Vespertilio* in common with all other bats.

Phyllostoma Lacepede, Tabl. Divis. Sous divis. Ordres et Genres Mamm., 1799, p. 16. This genus was established for certain of the leaf-nosed bats, and *Hemiderma* was at first included in it.

Carollia Gray, Mag. Zool. and Bot., II, 1838, p. 488. Gray constituted this genus for the reception of "*Carollia braziliensis*" and "*Phyllostoma brachyotum* Pr. Max." It has been generally assumed that *C. braziliensis* and *P. brachyotum* are synonyms. Gray, however, applied the name *braziliensis* in manuscript to a species of the genus *Tonatia*, probably basing it on the same specimen that *C. braziliensis* was founded upon, and as it is the first-named species it appears that *Carollia* should rather be considered a synonym of *Tonatia*. However, the question does not affect nomenclature as *Carollia* is preoccupied by *Carolia*[a] Cantraine, a genus of Mollusca.

Hemiderma Gervais, Exped. du Comte de Castlenau, Zoologie, p. 43, 1855. This name was proposed with *Hemiderma brevicaudum* Wied (= *H. perspicillatum*) as the type. Although Gervais figures the skull of a specimen from Bahia with complete zygomatic arches, his description is otherwise correct and applicable to this species and *Hemiderma* must stand as the valid name of the genus.

Rhinops Gray, Proc. Zool. Soc., Lond., 1866, p. 115. In this instance, as in many others, Gray failed to distinguish between generic and specific characters in his diagnosis and the description is in itself not determinable. Dobson, however, pronounced the type-specimen of *Rhinops minor*, which was made the basis of the genus, to be *Carollia brevicauda* (= *H. perspicillatum*). This opinion has been confirmed by Mr. Gerrit S. Miller, jr., who has kindly reexamined the specimen for me.

SPECIFIC NAMES.

perspicillatum (*Vespertilio*) Linnæus, Syst. Nat., 10th ed., p. 31. This is the valid name for the South American form.

brevicaudum (*Hemiderma*) Wied, Schinz' of Thierreich, I, 1821, p. 164. This name was in current use for the South American species (and

[a] I follow current usage in considering *Carollia* and *Carolia* to be the same name.

generally for all the forms of the genus) for eighty years. The rediscovery of Seba's specimens have shown that the name is a synonym for *perspicillatum*.

brachyotum (*Phyllostoma*) Wied, Schinz' Thierreich, I, 1821, p. 164. This name, originally proposed on the same page as the preceding, has been variously accredited to Wied's Beiträge zur Naturgeschichte Brasiliens (1826) and to Burmeister's Thiere Brasiliens (1854). The type could not be found by Professor Peters in 1865, and he was in some doubt as to whether the name was intended to refer to this species or to another. It appears to me that it was undoubtedly founded upon a dark phase of the same species as *brevicaudum*, and therefore it is also a synonym for *H. perspicillatum*. Indeed, it is difficult to tell from the lengthy description given by Wied in his Naturgeschichte just what differences he thought he distinguished between the two species.

soricinus (*Vampyrus*) Spix, Simiar. et Vespert. Brasil, 1823, p. 65, pl. XXXVI, figs. 2 and 6. One figure which Spix gives of his *Vampyrus soricinus* appears to be a *Hemiderma*, while the other, which he referred to the same species, is apparently a *Glossophaga*. Professor Peters examined the type which was from Rio de Janeiro, and pronounes it to be a *Carollia brevicauda* (= *Hemiderma perspicillatum*). The artist figured the skull with a complete zygomatic arch, although the text expressly states that the zygoma is incomplete.

grayi (*Phyllostoma*) Waterhouse, Voyage of the Beagle, 1839, Zoology, p. 3, pl. II. Waterhouse based his description upon specimens from Pernambuco. Peters and Dobson both place the name in synonymy with *C. brevicauda* (= *H. perspicillatum*).

calcaratum (*Phyllostoma*) Wagner, Archiv f. Naturgesch., I, 1843, p. 366. The first publication of this name has been generally accredited to the transactions of the Munich Academy, V, 1847, though in this citation Wagner refers to the original description in the Archiv for 1843. The type was from Brazil and the principal character noted is the extremely long calcar. Peters reexamined the specimen and found that what Wagner mistook for the calcar was in reality a portion of the interfemoral membranes which had become wrapped up in a stiff roll. On softening the membrane the calcar was found to be 7 mm. instead of 28, as given by Wagner.

verrucata (*Arctibeus*) Gray, List Mam. Brit. Mus., 1843, p. 19. This name was first published by Gray in the "List" without any description and with the habitat given as South America. In 1844 he republished the name,[a] placing the species in the genus *Carollia* and stating that it differs from *C. brachyotis* in the larger ears and ovate, triangular, acute-tipped tragus. Dobson and Peters both examined the type and pronounce it to be *brevicaudum* (= *perspicillatum*).

[a] Voyage of the Sulphur, Mamm., 1844, p. 20, pl. VIII, fig. 3.

Mr. Gerrit S. Miller, jr., recently reexamined the specimen and made the following notes: "Adult skin, with the skull removed but not cleaned. Color rather dark, in no way characteristic. Forearm, 38.5 mm.; third finger, 82; foot, 11.8; tibia, 16; upper tooth row, 7.4." The small size here given would seem to indicate that the specimen may actually be a representative of a small South American form allied to *subrufum*, but in the absence of more definite data in regard to locality and skull characters it seems best to regard the name, at present, as a synonym of *perspicillatum*.

bicolor (*Phyllostoma*) Wagner, Schreber's Saugeth., Suppl., I, 1844, p. 400. Wagner here renames the *Vampyrus soricinus* of Spix (antedated by *Phyllostoma soricinum* Geoffroy.) His description does not show any characters by which the species can be distinguished from *P. brevicaudum* Wied which is described on the next page. The type was from Brazil and the name is a synonym for *perspicillatum*

azteca (*Carollia*) Saussure, Rev. et Mag. Zool., 2me. ser., XII, 1860, p. 480, pl. xx, figs. 1, 1a. Saussure described this form from "Tropical and Temperate Mexico," giving as the principal character a lanceolate and pointed antitragus. After examining specimens of the genus from Mexico I cannot regard this character as having any value. The figure which Saussure gives of the tragus appears to have been drawn from memory some time after the specimens were last examined, while the figure of the feet resembles those of a *Glossophaga*. His measurements, however, serve to identify the species as the largest form of the genus known from Mexico. Peters, Dobson, and others have considered this to be identical with the South American species. Sufficient material is now at hand to show conclusively that it is a well-marked form, much larger than the South American bat, though connected with it by intermediate forms in Central America. *Azteca* therefore stands as the valid name for a form which is here recognized as a sub-species of *perspicillatum*.

minor (*Rhinops*) Gray, Proc. Zool. Soc., 1866, p. 115. No specific characters were given by Gray, but a new genus (*Rhinops*) was established and the type of the genus was given as "*Rhinops minor* sp. nov." Mr. Miller has recently reexamined the type for me and made the following notes upon it: "Type (49. 10. 15. 13.). [British Museum of Natural History.] Very young, milk incisors in place and permanent cheek-teeth not fully grown. Forearm, 35.5 mm.; foot, 11.7; tibia, 14.2. Color rather dark, in no way characteristic." The specimen was from Brazil and the name is a synonym of *perspicillatum*.

castaneum (*Carollia*) H. Allen, Proc. Amer. Philos. Soc., XXVIII, 1890, p. 19. This species, based upon a single alcoholic specimen, has been generally recognized by mammalogists. The species has

since been erroneously recorded[a] from Panama, but an examination of the specimens on which this record was based shows that they belong to the form *aztecum*, and the type, which is from Costa Rica, remains unique.

subrufum (*Hemiderma*) Hahn, Proc. Biol. Soc. Wash., XVIII, 1905, p. 247. This name was proposed for the smaller species known from Mexico. As mentioned in the original description, it does not appear to intergrade with any other known form and must be regarded as a distinct species.

MATERIAL.

In the preparation of this paper 374 specimens have been examined, most of which are in the collections of the U. S. National Museum. My thanks are due to Dr. C. Hart Merriam, Chief of the Biological Survey, U. S. Department of Agriculture; to Dr. J. A. Allen, Curator of Birds and Mammals in the American Museum of Natural History; to Mr. Samuel Henshaw, Curator of the Museum of Comparative Zoology, Cambridge, Massachusetts, and to Mr. J. A. G. Rehn, of the Academy of Natural Sciences, of Philadelphia, for the loan of specimens.

Genus HEMIDERMA.

Size medium, but heavily built; tail short, entirely enclosed in the interfemoral membrane excepting the tip which forms a little knob on the upper surface; free border of interfemoral membrane deeply notched; ears moderate; nose-leaf thick and broad; chin with a large wart in the center and a V-shaped double row of smaller warts on the sides.

Skull heavily built; zygomatic arches incomplete; palate prolonged backward in center beyond the line of the teeth, forming a sort of a tubular projection. Dental formula i. $\frac{2-2}{2-2}$, c. $\frac{1-1}{1-1}$, p. $\frac{2-2}{2-2}$, M. $\frac{3-3}{3-3}=32$. Middle upper incisors inclined toward each other at the tips, outer ones minute; middle lower incisors notched. Molars with a single internal cusp.

HEMIDERMA PERSPICILLATUM (Linnaeus).

Vespertilio perspicillatus LINNAEUS, Syst. Nat., 10th ed., 1758, p. 31 (based on *Vespertilio americanus vulgaris* SEBA, Locupl. rer. nat. Thes., 1734, p. 90).

Phyllostoma bernicaudum WIED, Schinz' Thierreich, I, 1821, p. 164.

Phyllostoma brachyotos WIED, Schinz' Thierreich, I, 1821, p. 164.

Vampyrus soricinus SPIX, Simiar. et Vespert. Brasil., 1823, p. 66, pl. XXXVI, figs. 2 and 6.

Phyllostoma brevicaudum WIED, Beitr. z. Naturgesch. Brasil., II, 1825, p. 192.—WAGNER, Suppl. Schreb. Säugeth., I, 1844, p. 401; V, 1855, p. 626.—BURMEISTER, Thiere Brasil., 1854, p. 41.

[a] Bangs, Bull. Mus. Comp. Zool., XLVI, p. 213, Jan., 1906.

Phyllostoma grayi WATERHOUSE, Voyage of the Beagle, Mamm., 1839, p. 3, pls. XI and XXXV.

Phyllostoma lanceolatum TEMMINCK (mss.); Gray, List Mamm. Brit. Mus., 1843, p. 20.

Phyllostoma calcaratum WAGNER, Archiv f. Naturgesch., I, 1843, p. 366.

Carollia verrucata GRAY, Voyage of the Sulphur, Mamm., 1844, p. 20, pl. VII.

Hemiderma brevicaudum GERVAIS, Exped. du Comte de Castlenau Amer. Sud., Mamm., 1855, p. 43, pl. VII.

Carollia brevicauda PETERS, Monatsb. k. Preus. Akad., Berlin, 1865, p. 519.—DOBSON, Cat. Chirop., 1878, p. 493.

Rhinops minor GRAY, Proc. Zool. Soc. Lond., 1866, p. 115.

Hemiderma perspicillatum THOMAS, Ann. and Mag. Nat. Hist., VIII, 1901, p. 192.

Hemiderma tricolor MILLER, Proc. Acad. Nat. Sci. Phila., 1902, p. 408.

Type-locality.—Not known. The type-specimen,[a] a young female, is in the British Museum of Natural History, Lidth de Jeude collection, and is probably from northern South America.

Geographic distribution.—Probably the whole of tropical and subtropical South America, Trinidad, the Lesser and perhaps the Greater Antilles. The southern limit of its range, so far as known, is Sapucay, Paraguay. The species has been taken at sea level within two degrees of the equator and at an elevation of 3,500 feet in the same latitude. The northern limit may be considered to be Panama, where it begins to intergrade with the subspecies *aztecum*.

Characters.—Size, intermediate between *H. p. aztecum* and *H. subrufum*, nearest the former; external edge of maxillary tooth-row only slightly concave (never with an angular curve); teeth moderately heavy; mandibles and mandibular teeth light.

Pelage.—The character of the pelage, as well as its color, is extremely variable. In general the color is darker than in any other form of the genus, and fewer individuals in the red phase are to be found, while none that I have seen have the bright ferruginous tinge observable in some of the specimens of *aztecum*. *Hemiderma tricolor* was founded on specimens from Paraguay "similar to *Hemiderma perspicillatum*, but with fur longer and more silky in texture and the three color-bands on the hairs of the back strongly contrasted."[b] These characters, however, do not prove to be distinctive, as the type of *H. tricolor* can be almost exactly matched by specimens at hand from Brazil, Trinidad, and Costa Rica, while two skins from Paraguay have short fur, reddish in color, and without strongly contrasted color-bands.

Fur and membranes.—Membranes blackish in color; interfemoral membrane sparsely furred at the base above and below, with a few

[a] Mr. Gerritt S. Miller, jr., has recently examined the type and made the following notes upon it: Female, not fully adult. Finger-joints not perfect, but milk-dentition all gone. Head and body, 65 mm.; tibia, 17; foot, 11.5; forearm, 39.4; third finger, 82; ear, from crown, 13.4; thumb, 11.4.

[b] Miller, Proc. Acad. Nat. Sci., 1902, p. 408.

minute hairs also scattered over the distal portion; legs and feet thinly covered with hairs, a number of stiff hairs at the base of the claws; forearms densely furred at base, the fur gradually becoming shorter and more sparse distally; base of thumb well covered with short hairs. Wing membranes from front of tarso-tibial joint, on a level with calcar.

Ear and tragus.—Ears rather short and broad; anterior edge strongly and evenly convex; posterior edge slightly concave in its upper two-thirds; outer side densely furred at base, naked at tip; internal side thinly haired at base; no distinct antitragus. Tragus variable, but usually acutely pointed; external edge with a more or less evident notch about one millimeter from the tip and three small lobes lower down, the upper one sometimes indistinct, the second thickened and glandular; internal edge slightly convex with a glandular swelling along the upper part.

Nose-leaf.—Nose-leaf broad, thick, tapering very sharply from the middle half to the tip, covered on both sides with minute hairs.

Skull and teeth.—Skull of medium size, but rather heavily built; brain-case rising abruptly from rostrum, broadly arched and wide, but not so wide relatively as in *H. subrufum;* interorbital constriction not pronounced; rostrum generally broad and flat, in certain specimens from Maranhão, Brazil, it is markedly narrow and pinched; teeth moderately heavy; the second upper premolar with a posterior elongation which, however, does not form a distinct heel or secondary cusp; teeth placed closely together, but not overlapping; line of maxillary tooth-row not sharply curved; last upper molar with or without a distinct posterior cusp. Mandibles light.

Specimens examined.—Total number 145, from the following localities:

Paraguay: Sapucay, 23.

Brazil: Sao Paulo, San Sebastio, 2; Maranhão, 10; Purus River, 1.

Trinidad: 80.

Venezuela: Maripa, 2; Ciudad Bolivar, 2; San Julian, 2.

Ecuador: Paramba, 5; Pambilar, 4; San Javier, 4.

British Guiana: Berbice, 3.

Colombia: Santa Marta, 10.

West Indies: Redonda, 3.

Remarks.—This species appears to be the most generalized of any of the genus. Although the range here given includes practically all of South America, it is impossible to separate it into more than one form on the basis of the material now at hand. Specimens from Paraguay have a slightly smaller average size than those from farther north and also an average difference in color; but these differences are bridged by one or two specimens. The ten specimens at hand from Maranhão, Brazil, show a very great cranial variation, and, were there

no intermediates, I should unhesitatingly say that the extremes belong to two distinct species. The Ecuador specimens also show some variation from those from other localities, the rostrum being very broad and short, with the brain-case long and expanded basally. Skulls of the two specimens seen from British Guiana are larger than any others from South America, and in this respect approach the subspecies *aztecum*. Two adult specimens from the island of Redonda closely resemble those from Trinidad, whence they have undoubtedly been derived.

Table of average skin measurements, in millimeters, of Hemiderma perspicillatum.

Locality.	Number of specimens measured.	Hind foot.	Calcar.	Tibia.	Forearm.	Third metacarpal.	Third finger.	Fourth finger.	Fifth finger.	Thumb.	Ear.	Nose-leaf.
Sapucay, Paraguay	9	10.8	7	17	40.3	35.7	85	61.6	61.8	11.2	16.7	8.1
Brazil	10	11.1	8.5	18.9	40.3	36.7	86.2	59.3	58.6	11.4	16.7	8
Trinidad	10	12.2	8.3	18	41	39	89.4	62	61.5	13	18.5	8.5
British Guiana	2	12	7.5	18.5	42	39	89	61.5	63	14	19.5	.....
Northern Ecuador	10	12	8.2	18.8	41.1	38.3	83	62.1	61	12.5	17	7

Table of average cranial measurements, in millimeters, of Hemiderma perspicillatum.

Locality.	Number of specimens measured.	Greatest length.	a Basilar length.	a Palatilar length.	Maxillary tooth-row.	Greatest breadth of brain-case.	Interorbital breadth.	Posterior palatal breadth.	Depth of brain-case from condyle.	Condylo-mandibular length.	Mandibular tooth-row.
Sapucay, Paraguay	8	22	17.3	9.5	7.5	10	5.8	7.7	8.9	14.5	8.7
Sao Paulo, Brazil	2	21.1	17.5	9.5	7	9.7	5	8	9	14.3	7.7
Maranhão, Brazil	5	21	16.7	8.9	7	9.5	5.1	6.9	8.2	14.1	8
Trinidad	5	22	17.5	10.2	8	10	5.8	7.8	9	14.5	9
Berbice, British Guiana	2	23	17.7	10	8.5	10.7	6	8.2	9.7	15	9
Ciudad Bolivar and Maripa, Venezuela	4	21.5	17	9.7	7.5	9.8	5	7.2	8	14.8	8.2
Minca and Bonda, Colombia	9	22	17	9.8	7.6	10	5.1	7.8	8.8	15	8.2
Paramba and San Javier, Ecuador	10	22	17.6	10	8	10.5	6	8.5	9.5	14.5	8

[a] As defined by Thomas.

HEMIDERMA PERSPICILLATUM AZTECUM (Saussure).

Carollia azteca Saussure, Rev. et Mag. Zool., 2me ser., XII, 1860, p. 480, pl. xx, fig. 1.

Carollia brevicauda Peters, Monatsber. K. Preus Akad., Berlin, 1865, p. 520.—Dobson, Cat., 1875, p. 492.—Trouessart, Cat., 1897, p. 156.

Hemiderma brevicauda Miller and Rehn, Proc. Bost. Soc. Nat. Hist., XXX, 1901, p. 283.

Hemiderma perspicillatum Elliot, Pub. Field Col. Mus., Zool. Ser., IV, Pt. 2, p. 668, figs. 141, and cxv; Zool. Ser., VI, p. 515.

Type-locality.—Temperate and tropical Mexico. Not definitely known.

Geographic distribution.—The hot, humid regions of southern Mexico and Central America from Panama as far north as Orizaba; exact limits of distribution not known.

Characters.—The largest known form of the genus (forearm, 42–44 mm.; skull about 23 mm.); skull large and massive, with high, broad brain case, and heavy teeth; ear, nose leaf, and tragus high, thick, and heavy.

Pelage.—Fur dense, but short. Color more variable than in any of the other forms of the genus. Some specimens from the lowlands of the Rio Tesechoacan, in southern Vera Cruz, are bright ferruginous in general appearance, the hairs being darker (near the mars brown of Ridgway) on the basal third, the central band having the characteristic color, and this in turn being minutely tipped with bright chestnut. Other specimens from the same locality are much darker in color. Skins from Tuxtepec, Oaxaca, have the proximal color band buffy white, and this is concealed by about 4 mm. of bright hazel, which gives the predominant tint to the fur when not disarranged. Certain specimens from Costa Rica are still darker, having the basal and outer bands of a sooty color near the clove brown of Ridgway, while the central band is grayish white.

Membranes.—The membranes differ in no essential manner from typical *H. perspicillatum.*

Ear and tragus.—The ear is higher than in the typical form, with the anterior edge less convex and the tip less broadly rounded. Tragus slightly higher and broader.

Nose leaf.—The nose leaf is wide and tapers more gradually to the tip than in *H. perspicillatum.*

Skull and teeth. Skull long and heavy, with a high, broadly arched brain case, which slopes gradually to the elongated and broad rostrum; palate broad; basal region of the skull massive; interorbital constriction angular; zygomatic process of the maxillary heavy. Teeth large, but the internal cusps of the molars relatively small; canines, premolars, and middle incisors very heavy; internal cusps of the first molar rounded and less angular than in *perspicillatum.*

Specimens examined.—Total number 177, from the following localities:

Panama: Panama, 7; Boqueron, 6; Colon, 9.

Costa Rica: Monte Redondo, 3; Juan Viñas, 2; San Sebastian, 2.

Nicaragua: Escondido River, 50 miles from Bluefields, 12.

Mexico: Apazote near Yohaltun, Campeche, 2; Jaltipan, 13; Rio Tesechoacan, near Perez, Vera Cruz, 68; Buena Vista, 1; Tuxtepec, Oaxaca, 51.

Remarks.—"*Carollia aztecum*" was described by Saussure from "temperate and tropical Mexico," the principal character assigned to it being a "lanceolate and pointed antitragus." This was doubtless due

to the drying of the skins in an abnormal position, as he himself suggests, for I have not seen any such character in the specimens examined. His figures of the tragus and of the legs and membranes are characterless. But, fortunately, his measurements serve to show that the species he had was neither *subrufum* nor *castaneum*, and the name is therefore adopted for the only other known form from that region. No definite type locality is assigned in the original description, which implies that specimens were examined from more than one locality. Among the specimens examined by the present author those from the lowlands of the eastern coastal region of southern Mexico show the greatest amount of differentiation from the typical *perspicillatum*, and, as it seems quite probable that some of Saussure's specimens may have come from that region, specimens from Rio Tesechoacan, near the town of Perez, in Vera Cruz, are assumed, for the purposes of this paper, to be typical.

Central American specimens are intermediate between those from Vera Cruz and Oaxaca and those from South America. Should the accumulation of more material from that region show that these differences are marked and constant it may become necessary to separate them as another subspecies, but such a course does not seem advisable at the present time in view of the great variations which are found among specimens from the same locality.

Average skin measurements, in millimeters, of Hemiderma perspicillatum azteeum.

Locality.	Number of specimens measured.	Hind foot.	Calcar.	Tibia.	Forearm.	Third metacarpal.	Third finger.	Fourth finger.	Fifth finger.	Thumb.	Ear.	Nose leaf.
Colon, Panama	9	12.4	7.1	19.8	41.9	38.3	88.6	62	60.8	11.3	17	7.3
Panama, Panama	a 6	12	7.5	.....	42	40	94	64	66	14.5	19	.....
Nicaragua	9	13	7.8	19	42.2	39	89	64	61	12.5	18.3	8
Rio Tesechoacan, Vera Cruz.	13	12.9	8.5	20.3	43.7	39.5	93.5	64.1	65	13.5	19	8
Tuxtepec, Oaxaca	11	12.7	9	20.5	44	39	90.3	63.4	64.3	12.6	19.5	8.2
Apazote, Campeche	a 2	14.5	10	19.5	43.5	41	.....	.....	.....	14	17.5	7.5
Jaltipan	a 13	14	9.5	19	43	41	.....	.....	.....	14	17.7	7.3

a Measurements taken from dry skins.

Average cranial measurements, in millimeters, of specimens of Hemiderma perspicillatum aztecum.

Locality.	Number of specimens measured.	Greatest length.	Basilar length.	Palatilar length.	Maxillary tooth row.	Greatest breadth of brain case.	Interorbital breadth.	Posterior palatal breadth.	Depth of brain case from condyle.	Condylo-mandibular length.	Mandibular tooth row.
Tuxtepec, Oaxaca, Mexico	8	24	18.2	10.2	8.2	10.3	5.8	8.2	9.2	16.2	9
Rio Tesechoacan, Vera Cruz	6	24	.....	10	8.2	10.5	6	8.5	9.3	15.8	9
Costa Rica	2	23.5	19	11	8	10.8	6	8.2	9	.....	.....
Yohaltun, Campeche	2	24.2	19.5	10.2	8.5	11	5.5	8.5	10.5	15.7	10
Colon, Panama	3	22.3	18	10	8	10.5	6	8.2	9.5	.....	.....
Boqueron, Panama	6	21.8	17.8	10	8	10.1	5.5	8	8.8	15.2	8.7
Panama, Panama	6	22.6	17.5	9.8	8	10	5.1	8	9	15	8.3

HEMIDERMA SUBRUFUM Hahn.

Hemiderma subrufum Hahn, Proc. Biol. Soc. Wash., XVIII, Dec. 9, 1905, p. 247.

Type-locality.—Santa Ifigenia, near the west coast of Oaxaca, Mexico. (Type-specimen, skin and skull, Cat. No. 75, 127, U.S.N.M., Biological Survey Collection.)

Geographic distribution.—Southern Mexico. Limits of distribution not known.

Characters.—Size intermediate between *Hemiderma perspicillatum* and *H. castaneum* (forearm about 39 mm.); skull small and short (about 21) with a high, strongly arched brain-case; maxillary tooth-rows with an angular curve between the premolars so that they are strongly divergent posteriorly; second premolar with a distinct posterior process.

Pelage.—The fur is short and sparse and rather coarse. "Ten skins from the type locality are uniformly of a dark reddish-brown color above. The individual hairs are banded as follows: A very short (not over ½ mm.) basal area whitish; next a wider band of dark (near the clove brown of Ridgway) which is followed by another and wider band of buffish white; succeeding this is the somewhat narrower band of reddish prout's brown which gives to the animal its characteristic color; hairs minutely tipped with whitish. Underparts similar, but the bands of color less sharply marked off, the dark bands being reduced and the pale areas suffused, making the general color paler and duller." Specimens from near Yohaltun, Campeche, are slightly darker, while some from Achotal, Vera Cruz, in the collection of the Field Columbian Museum are more pallid, due to the fact that the central pale band of the hairs is wider and the outer band of prout's brown less reddish. The forearm is densely furred at the base, the hairs becoming shorter and more scattered distally, but the fur is more dense on the distal half than in *perspicillatum* or *aztecum*. Tibia sparsely covered with short hairs.

Membranes.—The membranes are thinner and more brownish than *perspicillatum;* wing membranes usually from distal end of tibia slightly above the level of the calcar, the position of attachment varying somewhat. Calcar weak.

Ears and tragus.—Ears narrow and pointed, the edges comparatively straight. Tragus variable, essentially as in *perspicillatum.*

Nose-leaf.- Nose-leaf narrow and thin, tapering gradually to the tip.

Skull and teeth.—Skull small, with a high, strongly rounded brain-case and short, broad rostrum; palate wide posteriorly, narrowed anteriorly. Teeth small, the canines and premolars being especially reduced; longitudinal axis of the second premolar not in a plane parallel to that of the first premolar and canine, but with the anterior edge turned in so that there is a distinct angle in the line of the tooth row at that point; second premolar with a distinct posterior process or heel; internal cusp of first molar relatively large. Mandibles and mandibular teeth small and weak; the lower edge of the mandibles without a distinct downward curve at the symphysis; coronoid process only slightly anterior to condylar process.

Specimens examined.—Total number 55, from the following localities, all in Mexico:

Colima: Hidalgo Magdalena, 7.

Oaxaca: Santa Ifigenia, 20.

Vera Cruz: Otatitlan, 1; Minatitlan, 1; Coatzacoalcos, 1; Mirador, 2.

Campeche: Apazote, near Yohaltun, 21.

Yucatan: Merida, 1.

Honduras: Patuca River, 1.

Remarks. *Hemiderma subrufum* is in a way intermediate between *H. perspicillatum* and its subspecies, *aztecum* on the one hand and *H. castaneum* on the other, though apparently not intergrading with either. From the former it differs in its smaller size and lighter dentition and smaller and differently shaped skull; *castaneum*, on the other hand, is much smaller and has the cranial and dental peculiarities of *subrufum* carried to the extreme.

Table of average skin measurements, in millimeters, of Hemiderma subrufum.

Locality.	No. of specimens measured.	Hind foot.	Calcar.	Tibia.	Forearm.	Third metacarpal.	Third finger.	Fourth finger.	Fifth finger.	Thumb.	Ear.	Nose-leaf.
Santa Ifigenia, Oaxaca	8	12.1	7.1	16.7	39	36.7	86	60	60	13.7	17.7	8
Hidalgo Magdalena, Colima	7	12.4	6.9	17	39.9	34.9	81	57	58	12.4	16.5	7
Apazote, Campeche	a 4	12	7.2	16	38	36	.....	.....	.....	13	16.2	7
Patuca River, Honduras	1	13	7	17	39	38	88	62	62	15	17	8

a Measurements from dried skins.

Table of average cranial measurements, in millimeters, of Hemiderma subrufum.

Locality.	Number of specimens.	Greatest length.	Basilar length.	Palatilar length.	Maxillary tooth-row.	Greatest breadth of brain-case.	Interorbital breadth.	Posterior palatal breadth.	Depth of brain-case from Condyle.	Condylo-mandibular length.	Mandibular tooth-row.
Hidalgo Magdalena, Colima	4	21.5	17	10	7.2	10	5.5	7.8	8.2	14.5	7.2
Santa Ifigenia, Oaxaca	9	20.8	16.8	9.8	7	10	5.7	7.8	7.8	14	8
Yohaltun, Campeche	2	21.2	17	10	7.2	10	5.5	×	9	14.5	×
Patuca River, Honduras	1	22	17	9.5	8	10.5	6	8	9	.....	.....

HEMIDERMA CASTANEUM (H. Allen).

Carollia castanea H. Allen, Proc. Am. Philos. Soc., XXVIII, 1890, p. 19, read Dec. 6, 1889, printed Feb. 25, 1890, fig.–; Proc. U. S. Nat. Mus., XIII, 1895, p. 292, Nov. 15.

Hemiderma castaneum Trouessart, Cat. Mamm., 1897, p. 157.—Miller and Rehn, Proc. Bost. Soc. Nat. Hist., XXX, 1901, p. 233.—Elliot, Field Col. Mus. Pub., Zool., 4th Ser., p. 670; VI, p. 516.

Type-locality.—Costa Rica (Type-specimen, Cat. No. $\frac{12914}{36384}$, U.S.N.M., male adult preserved in alcohol, with skull removed).

Geographic distribution.—Known only from the type-locality.

Characters.—The smallest species of the genus (forearm, 35 mm.); skull short (about 20), relatively broad, and lightly built, zygomatic processes of the maxillary long and slender; teeth small, the outer edge of the last upper premolar on a line with the internal cusp of the first molar.

Fur and color.—Doctor Allen says in the original description: "Fur long and silky. Above, lustrous light chestnut brown at basal one-half and at the tip. The intervening portion is yellow brown (old gold). Below the same colors prevail, excepting that over the abdomen and pubis the brownish tip is absent and the body of the hair is not golden." Since this was written the skin has been immersed in strong alcohol for sixteen years and the bands of color are no longer distinct, but the rich golden chestnut tinge is still evident. This is probably an individual character, however, as it can be almost exactly matched in specimens of *aztecum* from Vera Cruz which differ from it very markedly in size and cranial and other characteristics. The distribution of the fur upon the limbs and membranes can not be determined, as they have been rubbed, but there is still a little fur at the base of the thumb and on the toes; interfemoral membrane well furred above on the basal half.

Membranes.—Membranes, brownish; the wing membrane arising from the distal end of the tibia, the interfemoral membrane from the tarsus about 1 mm. lower. Doctor Allen states that the interfemoral

membrane is not incised. It has been stretched so that this point can not now be definitely determined, but I strongly suspect that it is incised as in other members of the genus and that its stretched condition (which enables one to draw the hinder edge out straight) caused Doctor Allen to err. Calcar very slender and weak.

Ears and tragus.—Ear deeply emarginate on outer border;[a] inner border not as convex as in other species and tip blunt. The tragus is triangular in outline, with the glandular swelling of the inner edge less evident than in any of the other species; outer edge notched as in other forms except that there is no "shoulder" near the tip, while there is such a one near the tip on the inner side, something I have not seen in any other specimen that I have examined.

Nose-leaf.—The nose-leaf is long and slender, brown in color except at the tip and the upper margin, which are pale (possibly from being rubbed).

The chin has been described and figured as having warts arranged in the usual way, but it has now been so stretched and rubbed that they can not be distinguished.

Skull and teeth.—Skull short and relatively broad; brain-case low and widely arched; audital bullæ small; zygomatic processes of the maxillary long and slender. Teeth essentially as in *H. subrufum* in structure, but all of them smaller and their arrangement somewhat different; lines drawn along the outer edges of the canine and premolars of the two sides of the upper jaw would be about parallel and would cut off the inner cusp of the first molar; the outer edge of the first upper molar projecting considerably beyond the outer edge of the last premolar so that there is a sudden break in the line of the tooth-row; a space between the first and second premolars of both jaws. Other jaw teeth all close together.

Remarks.—*Hemiderma castaneum* is the most aberrant form of the genus, differing from all the other known forms in its small size and slender build, in the form of the ears and of the maxillary tooth-row, and in the long, slender zygomatic process. The type is a young adult male with unworn molars, but it is much smaller than specimens of other species which are far more immature.

Mr. Outram Bangs has recorded the species from Panama,[b] but the specimens, which are in the Museum of Comparative Zoology at Cambridge, prove to have been erroneously identified and the type remains unique.

[a] One ear has been stretched out smooth and when opened backward and laid on the head it appears to be very slightly emarginate; the other is contracted by a number of oblique and transverse ridges radiating from a point about 10 mm. below the tip, which contract the outer edge at that point to form a deep notch. This wrinkled condition appears to have been the normal one during life.

[b] Bull. Mus. Comp. Zool., XLVI, p. 213, Jan., 1906.

Measurements of the type: Hind foot, 11 mm.; calcar, 6; tibia, 14; forearm, 35; third metacarpal, 34; third finger, 82; fourth finger, 58; fifth finger, 57; thumb, 12; ear, 14; nose-leaf, 6. Cranial measurements of type: Greatest length, 20; basilar length, 16; palatilar length, 8; maxillary tooth-row, 6.5; greatest breadth of brain-case, 9; interorbital breadth, 5; depth of brain-case from condyle, 8; condylo-mandibular length, 13; mandibular tooth-row, 7.

TWO NEW LAND SHELLS FROM MEXICO.

By Paul Bartsch.

Assistant Curator, Division of Mollusks, U. S. National Museum.

Among a consignment of Mexican mollusks transmitted to the United States National Museum by Prof. A. L. Herrera for determination, there are two forms of *Drymæus*, which have not been previously noted. These are here described and figured.

DRYMÆUS HERRERÆ, new species.

Shell ovate, conic, thin, translucent, maize-yellow with a little darker colored apex. Nepionic turns two, moderately rounded, having the typical grated sculpture. Succeeding whorls moderately rounded, marked on the spire and base by strong, longitudinal wrinkles, which are little wider than the spaces that separate them. The entire surface is also crossed by numerous very fine, closely, and subequally spaced spiral striations, which are a little more strongly developed about the umbilical area of the base than near the summit of the turns. Sutures strongly impressed, rendered subserrulate by the wrinkles on the summit of the whorls. Base narrowly perforate, the umbilicus being partly concealed by the white, straight columella, which is broadly expanded and reflected at the base. Aperture decidedly oblique, oval, outer lip thin, semitransparent.

Fig. 1.—Drymæus herreræ.

Four specimens of this species were collected by Prof. H. L. Herrera at Bonanza Zimapan, Hidalgo, Mexico. The type and one additional specimen form Cat. No. 192992, U.S.N.M. The type has six and one-eighth whorls and measures: Altitude, 20 mm.; greater diameter, 10 mm.; lesser diameter, 9 mm.; length of aperture, 10.3 mm. Another specimen has six and one-fifth whorls and measures: Altitude, 21.3 mm.

An immature individual shows a faint angulation at the periphery.

DRYMÆUS HERRERÆ VERACRUZENSIS, new subspecies.

Shell like *D. herreræ* but a trifle stouter and stronger, marked by three dark brown spiral color bands, of which the posterior two show strongly upon the spire of the last three whorls; on the earlier whorls they are marked very faintly only. The upper band is the narrowest, and girds the whorls a little posterior to the middle between the sutures. The middle one is the broadest; it is situated immediately above the periphery, being completely exposed above the suture; the basal one, which is about half as wide as the peripheral band, encircles the base a little posterior to its middle. The white columella is strong, straight, and broadly expanded and reflected at base.

FIG. 2.—DRYMÆUS HERRERÆ VERACRUZENSIS.

The type has six and one-eighth whorls and measures: Altitude, 23 mm.; greater diameter, 11.5 mm.; lesser diameter, 10 mm.; aperture altitude, 12.3 mm. The type was collected by Prof. H. L. Herrera at Cordova, Vera Cruz, Mexico, and is entered as Cat. No. 192993, U.S.N.M.

REPORT ON THE MOSQUITOES OF THE COAST REGION OF CALIFORNIA, WITH DESCRIPTIONS OF NEW SPECIES.

By Harrison G. Dyar.

Acting Assistant Curator, Division of Insects, U. S. National Museum.

The writer visited California to make collections for the United States National Museum with the idea that there were but few species of mosquitoes to be found there, and those mostly well known. The larvæ of a few were desired, and these it was hoped to find. Most of the time, May 8 to July 21, was spent in the vicinity of Los Angeles, after the seasonal rains were over. The country soon became very dry, but it was evident that few of the species, so characteristic of the temporary pools in the East, exist on the coast of California, except those supplied by the periodical high tides, so that there was little loss on this account. Practically all the species belong to the group inhabiting permanent water, something of a paradox for an arid country that is supposed to have no permanent water, and where all the streams go dry. The condition is that temporary water is so exceedingly temporary that no larvæ can exist in it; all the water that gathers belongs to the permanent type, in lakes, marshes, pools in river beds, well holes, and barrels.

Eighteen species were met with in the coast region from San Diego to Eureka. The mountains were not explored. They should yield a different set of species, probably some of the temporary pool species that breed in snow water. I was told that mosquitoes were abundant and troublesome this season in the Yosemite Valley, but had no opportunity to investigate them.

ANOPHELES MACULIPENNIS Meigen.[a]

The "malarial mosquito" was not uncommon in marshes, though none were seen in town. Specimens were taken at Tia Juana, Mexico, Gardena, Sweetwater Junction, Laguna, San Onofre, Salinas, Guadaloupe, Eureka, Sisson, and Thrall, California, mostly as larvæ in permanent water.

[a] This name will have to be changed. In a paper with Mr. Knab I have shown the corrected nomenclature. The California form is *Anopheles occidentalis* Dyar and Knab.

ANOPHELES PUNCTIPENNIS Say.

Not nearly as common as the preceding, the conditions obtaining on the Atlantic coast being reversed here. In fact I am not certain that the species occurs in Southern California, the only record being a single damaged male, bred from a larva at Sweetwater Junction near San Diego. The other specimens of the species were obtained farther north, Chico, California; Portland, Oregon; Nanaimo, Duncans, and Wellington, British Columbia. Miss McCracken obtained the species, rather plentifully, near San Francisco several years ago.

ANOPHELES FRANCISCANUS McCracken.

The species occurred less abundantly than *maculipennis* in the same locations; bred specimens were obtained from Tia Juana, Mexico; Clearwater, near Santa Ana, and Sweetwater Junction, near San Diego. Miss McCracken described the species from Palo Alto.

PSOROPHORA CILIATA Fabricus.

A specimen is in the collection of the U. S. National Museum, taken by Mr. D. W. Coquillett in Los Angeles. I did not meet with the species, and it is quite likely that the remarkable growth of the city has destroyed the breeding places since the time that Mr. Coquillett collected there. The breeding places are temporary puddles occurring after rain, when filled by other mosquito larvæ. Such puddles probably occur in California, though I did not encounter any. They must be rare, as evidenced by the scarcity of the species breeding in them. The larvæ of *Psorophora ciliata* usually feed upon *Janthinosoma* larvæ, but as these do not occur in California they must live on *Aedes sylvestris*. The same conditions obtain in Massachusetts and northern New York, where *Psorophora ciliata* exceeds the range of *Janthinosoma*, and doubtless there also *Aedes sylvestris* is the victim.

CULISETA INCIDENS Thomson.

Common, the larvæ occurring in rain barrels, reservoirs, etc., as well as little pools by the streams. They were never in large numbers. The species occurred everywhere up the coast, being, if anything, more abundant in Oregon, Washington, and British Columbia. Californian localities are: Pasadena, larvæ in a water box in the arroyo and in a pond in a lawn; Los Angeles, in water in a cellar; San Diego, in a road puddle fed by a leak in a water pipe and in an old water vat on a wharf; Avalon, Santa Catalina Island, in a rain-water barrel; San Luis Obispo, in an old tin can; San Francisco, in water in a cellar in the burnt district; Eureka, in various barrels; Dunsmuir, in pools by the railroad track; Sisson, in the still edge of a ditch of cold water flowing rapidly.

CULISETA INORNATUS Williston.

This species has been going under the name of *consobrinus*, but I am unable to agree with this identification of Robineau-Desvoidy's name, and use Williston's instead. The species was scarce, but was bred from larvæ at Laguna, Eureka, and Sisson, California, and commonly at Klamath Falls, Oregon. At the latter place pairs were observed *in coitu*, resting on the underside of some boards over water. They were captured and did not separate even in the cyanide bottle.

CULISETA MACCRACKENÆ Dyar and Knab.

This species has been taken at San Francisco (Miss McCracken) and Eureka (H. S. Barber), but I was not so fortunate as to meet with it. The larva is unknown to me. It is the species formerly identified with the European *annulatus* Meigen.

CULEX TARSALIS Coquillett.

A common species, but not troublesome, as the adults never bite by day and are sluggish in their attack even at night. Moreover, the species does not breed in water receptacles near dwellings, such as rain barrels. Larvæ occurred in marshes and puddles, in river beds, and even in grass in the edges of lakes. Brackish water, when standing permanently near the sea, was also a breeding place. The species extends to the north through Oregon, Washington, and British Columbia, as well as east to the Mississippi Valley.

CULEX STIGMATOSOMA, new species.

Head with black and golden scales behind, side of occiput pale gray; eyes narrowly white behind; proboscis black with a white band a little beyond the middle; palpi and antennæ black. Thorax bronzy brown with longitudinal striation, a round whitish spot on each side at the middle, from which an obsolete pale stripe runs backward; sides sparsely pale yellowish scaled, the integument greenish at the bases of the legs. Legs black, the femora whitish below, no white lines above; tibiæ black with a small white apex and a long whitish line within; tarsi black, a white ring at base and apex of each joint, including the terminal joint. Abdomen black, with broad white bands on the bases of the segments above, whitish scaled below with a row of median segmentary round diffuse black spots. Wing scales narrow, entirely black, not forming spots.

Three hundred and twenty-two specimens, Pasadena, California, larvæ in a pond in a lawn; Laguna, larvæ in a well hole by the edge of a lake; San Diego, in an old water vat on a wharf; Sweetwater Junction, in pools in a stream bed; San Luis Obispo, in a pool in a rocky canyon (A. N. Caudell); Avalon, Santa Catalina Island, in a rain-

water barrel; Chico, in a horse trough (A. N. Caudell); Plant Introduction Garden, near Chico, in a barrel in a small stream; Klamath Falls, Oregon, a captured specimen.

Type.—Cat. No. 10008, U.S.N.M.

The larva falls in the table[a] with *pipiens* and *cubensis;* it has the tube five times as long as wide, somewhat fusiform in shape, the pecten with about 11 teeth; lateral hairs of the third and fourth abdominal segments in threes.

This species has, no doubt, been confounded with *tarsalis* Coquillett, but it differs conspicuously in the coloration of the underside of the abdomen, which has only a row of round black spots, while in *tarsalis* there is a series of doubly bent transverse bars.

CULEX ERYTHROTHORAX, new species.

Head golden, reddish scaled behind, the eyes with a narrow white border; proboscis blackish; palpi red brown; antennæ black. Thorax light red, the scales fine, golden brown, striped by two impressed discolorous areas in the membrane; sides light golden scaled; legs blackish, the femora and tibiæ broadly pale below, unbanded. Abdomen black above, mixed with pale ocherous scales, the bases of the segments with rather narrow pale ocherous bands mixed with a few dark scales; beneath with pale ocherous scales and golden hairs.

Eighty specimens, Nigger Slough, Gardena; slough at San Onofre; Sweetwater Junction, swamp full of reeds; Guadaloupe, slough covered with reeds (A. N. Caudell); Salinas, California, a pool in a river bed choked with vegetation.

Type.—Cat. No. 10009, U.S.N.M.

The adults could only be taken in the midst of the tall reeds that covered shallow sloughs by wading into the water. A person sitting on the bank was immune from their attacks, but among the reeds they bit viciously in the daytime. The larvæ occurred among the reeds, resting quietly at the surface in the *Lemna*, though fish were present in all the sloughs. *Culex tarsalis* and *Anopheles* were generally present also, the mass of vegetation doubtless shielding them from the fish.

CULEX CUBENSIS Bigot.

This common house mosquito occurred in the South, but soon became scarce and finally absent northward. The localities are: San Diego, larvæ in an old water vat on the wharf; National City, in a rain barrel; Sweetwater Junction, in pools in a stream bed; Indio, in a water barrel and a drain, the adults common and a nuisance at night (A. N. Caudell); Coachella, in a pond; Laguna, in a well-hole by a lake;

[a] Journ. N. Y. Ent. Soc., XIV, 1906, p. 206.

Avalon, Santa Catalina Island, in a rain-water barrel; Los Angeles, in water in a cellar; San Luis Obispo, in an old tin can. No specimens were taken any farther north.

CULEX TERRITANS Walker.

The larvæ occurred sparingly in permanent water, when clear and cold; no adults were taken except those bred: Pasadena, in a wooden water box in the arroyo, at Devil's Gate; in a large clear pool behind a clay dam in the arroyo at the Ostrich Farm; Sisson, in a springy, grassy meadow and in roadside puddles.

AEDES VARIPALPUS Coquillett.

The larvæ occurred in holes in live-oak trees in the arroyo at Pasadena. Farther north, where the oak does not grow, the species seems addicted to the alder; the conifers do not form holes suitable for the larvæ to breed in. Adults were taken at Dunsmuir, California; Ashford, Oregon; Seattle, Washington; Vancouver, Victoria, Nanaimo, and Wellington, British Columbia. Unlike any other North American species (except *Stegomyia calopus* Meigen), the males are attracted to the person as well as the females. While they can not bite, they occasionally alight, and several were so taken, supposed at first to be females about to bite. While sitting in the woods near Victoria, British Columbia, the writer observed a small swarm of males which gathered before him and continued to dance, one occasionally alighting for an instant, as long as he remained there. During this time two females came to bite and each was immediately seized by a male, the pair flying off in a downward direction in copulation, which lasted apparently but a few seconds.

AEDES SPENCERI Theobald.

Recorded from California by Miss Ludlow.[a] The species ranges with *curriei* in the North and should occur in California. I have not taken any specimens. The larva has never been found.

AEDES SYLVESTRIS Theobald.

Quayle gives this as occurring in California,[b] and no doubt with correctness, as it is known to me from Arizona. It is probably the species that forms the prey of *Psorophora ciliata* as larvæ.

[a] Medical Record, Jan. 30, 1906.

[b] Bull. 178, Agr. Exp. Sta., Univ. of Calif., 1906, pp. 52, 55.

AEDES VITTATUS Theobald.

Specimens so labeled by Mr. Coquillett have been taken at Eureka and Fieldbrook by Mr. H. S. Barber, May 22 to June 6, and one at Pacific Grove by Miss McCracken, July 2. Mr. Theobald described *vittata* from Pecos Canyon, New Mexico. We have three specimens from that place, sent by Mr. T. D. A. Cockerell, two of which are *sylvestris*, but the third appears to be Theobald's recent species. It agrees with his description except that the subcostal and first long veins are rather feebly white scaled. This character varies a good deal, and I am inclined to accept the identification. Mr. Barber, fortunately, took a male at Eureka, the hind tarsal claws of which are uniserrated as described by Theobald. The genitalia agree with those of *abfitchii* Felt.[a] No larvæ have been obtained in California, but the species was bred by me at Kaslo, British Columbia, and the larvæ agree with those of *abfitchii*. *Abfitchii* Felt, then, will be referred as a synonym of *vittata* Theobald, and the larva which has been attributed to *vittata* by Theobald will best be placed under *Culiseta incidens* Thomson. Everything points to this as an error of association.[b] The larvæ were collected by Messrs. Grabham and Cockerell in the latter part of June, a time when the larvæ of *vittata* (*abfitchii*) would have all disappeared. *C. incidens*, however, would then be flourishing and it might have been met with in any barrel or pool. *Incidens* is recorded in Mr. Theobald's paper, but there is no mention of the larva. The only other larva mentioned is that of *Culex tarsalis* (*kelloggii*), which is also a Summer species, occurring with *incidens*. These two larvæ are the ones always met with through the West, and are certainly the ones encountered by Messrs. Grabham and Cockerell, who, through some error, have attributed the *incidens* larvæ to the new species, *vittata* Theobald.

AEDES SQUAMIGER Coquillett.

This curious species lives in the salt marshes, in water left by the highest tides. Adults were taken at National City and Redondo Beach, and larvæ were twice obtained at the former place. It has also been taken around San Francisco Bay (McCracken; Quayle), but has not been observed farther north. Although the adult is so different from *quaylei* Dyar and Knab, the larva is almost identical,

[a] Dyar, Journ. N. Y. Ent. Soc., XIII, 1905, p. 186; Felt, Bull. 97, N. Y. Sta. Mus., 1905, pl. IX, fig. 1.

[b] See Dyar, Journ. N. Y. Ent. Soc., XII, 1904, p. 173; Dyar and Knab, Journ. N. Y. Ent. Soc., XIV, 1906, pp. 193, 203.

the two falling together in the table[a]. However, *squamiger* has multiple head hairs, while they are simple in *quaylei*, and there are some other differences in detail.

AEDES DAMNOSUS Say.

Larvæ were taken on the salt marsh at San Diego at the time *squamiger* was flying. Again, when *squamiger* was in larva, the *damnosus* were on the wing, their hatching and development following more immediately the inundation of the upper reaches of the marsh by the monthly tides than in the case of *squamiger*. I found the larvæ again at Carpinteria, near Santa Barbara, having just hatched in a high tide that filled the marsh. The species was not seen farther north, being replaced by *quaylei*. The habits of the larvæ differ somewhat from the *damnosus* of the Atlantic coast. There they inhabit pools removed from the immediate action of the tides, often largely or wholly fresh, though near the sea. In California they frequented the immediate tide water and developed faster than the other associated species. The difference may be due to climatic causes, as there are no partly or wholly fresh pools in California, all the water on the marsh coming from the sea, except the river channels, which are unfit for breeding.

AEDES QUAYLEI Dyar and Knab (*lativittatus* Coquillett).

The salt marsh species of the Pacific coast was not encountered south of San Francisco Bay. It was common in all suitable places farther north. These places are rather widely separated, as most of the coast is steep or rocky and forms no tide-water marshes. Larvæ were found in tide-water pools at Eureka, California, and Tacoma, Washington. The adults were taken also at West Seattle, Washington; Stanley Park, Vancouver, and Duncans, British Columbia. The dorsal thoracic band of dark brown is usually broad, but varies, in one specimen from the salt marsh being very narrow. This species is far less troublesome than its Atlantic representative, *Aedes sollicitans* Walker, although perhaps the most annoying of the California mosquitoes in the daytime. In Stanley Park, Vancouver, British Columbia, the species was really a nuisance in a limited area, though the adults had probably not flown over a mile from their breeding place at most. Miss Ludlow's record of the European *dorsalis* from California[b] probably refers to this species or to *curriei*. It is not probable that any European mosquito occurs in North America, except the domesticated *Culex pipiens* and perhaps the malarial *Anopheles*.

[a] Journ. N. Y. Ent. Soc., XIV, 1906, p. 191. Larvæ collected by Mr. Quayle and sent to Professor Smith and to me were invariably determined as *curriei* (*quaylei*), as we all supposed *squamiger* should have a very distinct larva. See Grossbeck, Can. Ent., XXXVIII, 1906, p. 129.

[b] Medical Record, Jan. 20, 1906.

AEDES CURRIEI Coquillett.

Adults which appear referable to this species were taken at Thrall, California, and Klamath Falls, Oregon. They are inseparable from *quaylei* by the dorsal marking of the thorax, as in one specimen the stripe is as broad as in the usual *quaylei*, in another narrow. There are, however, less black scales on the wings in these *curriei*, and I am reluctant to believe that they can be the same species as the salt marsh form. The larvæ, unfortunately, were not found, but we have them from Grand Junction, Colorado, collected by Mr. E. P. Taylor, and from Ithaca, New York, collected by Mr. O. A. Johannsen. These larvæ differ from *quaylei* in the structure of the comb, the scales of which end in a single stout spine. It is probable that the Californian ones will be found to have the same structure and thus be distinguishable from both *quaylei* and *squamiger*. The larvæ appear to come early, perhaps in the first temporary pools, and have but a single annual brood. The species was apparently absent from southern California and the coast region.

STEGOMYIA CALOPUS Meigen.

Mr. Knab tells me that he has seen a reference to the "yellow fever mosquito" as occurring on the coast of California. It is certainly not a native of the State. I did not meet with it even in the wharf vats at San Diego, which would seem the most likely place.

MANSONIA SIGNIFER Coquillett.

This has been recorded from California by Miss Ludlow. I have not seen any specimens. The larvæ are well known inhabitants of hollow trees, but our other records do not carry the species west of Missouri.

URANOTÆNIA ANHYDOR, new species.

A single larva was collected in a swamp full of reeds at Sweetwater Junction, near San Diego, which died before reaching home. Mr. Caudell and I made a special trip to the swamp later to get more larvæ, but it had gone dry, leaving little puddles of dying fish and a great quantity of *Anopheles* larvæ, all of which no doubt died within twenty-four hours.

Larva.—Head rounded, scarcely longer than wide, neck circular, the occiput oblique, roundedly angled at the side, then nearly straight, the front margin broadly, squarely truncate; labrum deeply excavate each side of the middle, forming a triangular horn-like prominence in the middle and one on each side, midway between the central one and the antennæ. Eyes large, semicircular, transverse; two approximate multiple hair tufts above and within the eye, another on

the lower part of the front on each side; a large multiple tuft about base of antennæ. No trace of the usual thick, club-like hairs; if they are broken, the insertions are not visible. Antennæ small, not exceeding the mouth brush, conically tapered on basal two-thirds, a few spines within, a single hair at about the basal third; four terminal digits, all long and pointed, nearly equal. Deep brown, nearly black, lighter at the margins of the eyes. Thorax nearly circular in outline, flattened; a minute double prothoracic subdorsal tuft, a larger lateral 2-haired tuft from a tubercle and a subventral tuft; mesothorax with a minute multiple subdorsal tuft in the disk, a large lateral one from a small, thorn-shaped tubercle and a large subventral tuft; metathorax with the subdorsal tuft many-haired and long but very fine, lateral tuft with four feathered hairs and a simple one from a thorn-like tubercle. Abdomen submoniliform, rather slender; a single long lateral hair on the first segment, two on the second, from large tubercles, the subdorsal hairs fine and stellate; on segments 3 to 8, the hairs are fine, in substellate bunches, but long, as long or longer than the diameter of the body, both subdorsal and lateral. Lateral comb of the 8th segment an irregularly quadrangular plate, reaching near the dorsal line, the nine short teeth set on its posterior edge on the lower two-thirds, thorn shaped, with fine lateral feathering; a single hair and two tufts behind the plate, the upper with a large tubercle. Air tube straight and not tapered, four times as long as wide, light brown, with a narrow black basal ring; a single tuft slightly before the middle, from a raised tubercle, just beyond the pecten, which has 16 teeth, broad, finely feathered, pallid. Anal segment ringed by the plate, about as long as wide, the chitinous ring excavated below to admit the short ventral brush; the brush has few tufts and is surrounded by a narrow chitinous band which joins the ring on the ventral line; a fringe of fine spines on the posterior edge of the plate. Dorsal tuft, a group of long hairs on each side. Anal gills small, slender, about as long as the segment, apparently four in number.

Type.—Cat. No. 10010, U.S.N.M.

NOTE ON OTOHIME, A NEW GENUS OF GURNARDS.

By David Starr Jordan and Edwin Chapin Starks,
Of Stanford University, California.

The species of gurnard described by Schlegel as *Trigla hemisticta* may be considered as the type of a new genus, *Otohime*, distinguished from *Chelidonichthys* ("*pictipinnis*," *kumu*, *hirundo*) especially by the absence of the dorsal armature characteristic of *Chelidonichthys*. The scales are very small, the lateral line unarmed, and there are no sharp-edged bony spines along the base of the dorsal fins. In place of these there are about three flattish bucklers along each side of the base of the spinous dorsal, and one buckler lunate in form across the median line in front of the first spine. The dorsal spines are strong, and the soft dorsal and anal are much shorter than in *Chelidonichthys*. The opercle ends in a very long spine. Vomer with few teeth; none on the palatines. The single known species *Otohime hemisticta* is rare in Japan, only one specimen having been seen by us.

Otohime in Japanese mythology is a goddess of fishes.

The genera of Triglidæ may be thus compared:

KEY TO GENERA.

a. Scales relatively large; teeth on vomer and none on palatines; a row of spinous bucklers along base of dorsal ..... *Lepidotrigla*.

aa. Scales relatively small.

b. Palatines without teeth.

c. Lateral line armed with spines or bony cross plates; teeth on vomer ... *Trigla*.

cc. Lateral line unarmed.

d. Base of both dorsals with a series of shields, each ending in a sharp spine directed backward. Opercular spine small; soft dorsal and anal long. Dorsal rays, IX–16; anal, 15; no anal spine ..... *Chelidonichthys*.

bb. Base of dorsal with blunt shields along base of spinous dorsal only; base of soft dorsal unarmed; opercular spine very long; soft dorsal and anal short; dorsal rays VIII–10, anal I, 11; the anal spine distinct ... *Otohime*.

bb. Palatines with teeth; no spinous plates along dorsal base nor along lateral line.

c. Head spinous above ..... *Prionotus*.

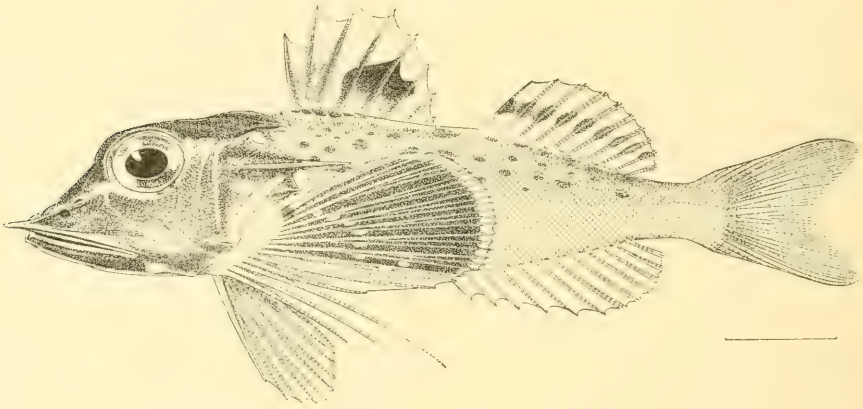
cc. Head unarmed above ..... *Calotrigla*.

OTOHIME HEMISTICTA (Schlegel).

The following are the characters of the type species of *Otohime*. Depth at occiput, 4½ in length to base of caudal; head (without opercular or rostral spines) 2¾. Eye, 3 in head; maxillary, 2. Dorsal, VIII–10; anal I, 11; scales, 105.

Anterior profile steep and straight from eyes to tip of snout. Supraorbital rim produced; interorbital broad and concave; its width equal to diameter of orbit.

Maxillary reaching to below middle of eye; mandible slightly curved up at its tip and shutting entirely within premaxillary teeth; teeth in very narrow bands, those on lower jaw in a narrower band than on upper; vomer of the specimen at hand without teeth, but marks on the bone show their probable former presence. A single rostral spine on



OTOHIME HEMISTICTA.

each side, equal in length to vertical diameter of pupil. Edge of preorbital finely serrate, the serræ extending along outer edge of rostral spine. A sharp spine is directed backward from temporal region, and a very long one from opercle continued as a ridge anteriorly nearly across opercle; length of spine from posterior edge of opercle equal in length to diameter of eye; a sharp spine on posterior edge of preopercle near its angle; a triangular spine on posterior edge of supraclavicle. The gill arches of our specimen have been removed.

Fine irregular scales cover the trunk; a crescentic naked area between dorsal and head; another naked area behind pectoral and ventral; round imbedded scales sparsely cover the breast; no scales on fins. A crescent-shaped rugose plate in front of base of first dorsal spine, and three round or elliptical ones behind it on each side of spinous dorsal, the last between the fourth and fifth spines.

Dorsal spines stiff and sharp; the fourth the longest, equal in length to the maxillary; when fin is depressed the fourth and fifth spines

reach beyond the others. Dorsal rays slender, once divided, rather widely spaced; the longest equal to vertical diameter of orbit. Anal as high as soft dorsal and extending a little posterior to it. Caudal lunate, its angles sharp. Pectoral reaching to opposite base of third anal ray, the three detached rays slender and pointed, the upper one but little shorter than the other pectoral rays, the lower one not reaching to tip of ventral. Ventral not quite reaching to vent.

Our specimen is apparently badly faded. It is now light gray above, abruptly white below middle of side; dark brown round and elliptical spots are scattered sparsely and irregularly over upper part of side. Spinous dorsal with a large clear-cut dark brown spot from fourth to sixth spines, fin otherwise transparent and colorless; soft dorsal with a row of brown spots, one on each ray; ventrals, anal, caudal, and detached pectoral rays colorless. Outer surface of pectoral with white rays and dark brown membrane bordered with white behind; when fin is closed the white of the rays only shows; inner surface more uniform dark brown and darker than outer surface, the rays lighter only toward their tips, the white border at posterior margin of fin more conspicuous, two rows of irregular milk-white spots across fin on the rays, encroaching on the membrane but slightly; the anterior row of large irregular spots the posterior of only three or four small round spots.

The specimen from which this description is drawn was brought by Mr. Pierre L. Jouy, from Yokohama. It probably came from Misaki or Awa, outside the Bay of Tokyo. It is 195 mm. in entire length.

The species of Triglidæ known from Japanese waters are the following, most of them described by Jordan and Starks in the Bulletin of the U. S. Fish Commission for 1902:

1. *Otohime hemisticta* (Schlegel) Yokohama.

2. *Chelidonichthys kumu* (Lesson and Garnot). (*Trigla spinosa* McClelland, Jour. Calc. Nat. Hist., IV, p. 396. *Cheledonichthys punctipinnis* Kaup, Archiv. f. Naturg. 1873. p. 87. The locality stated, evidently by error, as Barbados.)

Found throughout southern and middle Japan, very common; also in New Zealand and Australia.

3. *Lepidotrigla güntheri* Hilgendorf. (*Lepidotrigla longispinis* Steindachner.) Suruga Bay, Totomi Bay, Yokohama.

4. *Lepidotrigla abyssalis* Jordan and Starks, Suruga Bay.

5. *Lepidotrigla smithi* Regan. (Ann. Mag. Nat. Hist., 1905, p. 22.) Inland Sea of Japan; not seen by us.

6. *Lepidotrigla microptera* Günther. (*Lepidotrigla strauchii* Steindachner.) Aomori, Hakodate, Tsuruga, Matsushima, Hiroshima.

7. *Lepidotrigla japonica* (Bleeker). (*? Lepidotrigla serridens* Hilgendorf) Misaki.

8. *Lepidotrigla alata* (Houttuyn), (*Trigla burgeri* Schlegel), Nagasaki, etc.

THE PHILIPPINE POND SNAILS OF THE GENUS VIVIPARA.

By Paul Bartsch,

Assistant Curator, Division of Mollusks, U. S. National Museum.

In the present paper all of the species of this genus heretofore known from the Philippine Islands have been considered, as well as a host of new forms which were collected by Maj. Edgar A. Mearns, U. S. Army, and presented by him to the U. S. National Museum.

VIVIPARA ANGULARIS Müller.

Plate X, fig. 1.

Helix angularis Müller, Hist. Verm., Pt. 2, 1774, p. 187.

Shell quite large, conic, light to dark olive green. Whorls increasing very regularly in size. The first and second rather loosely coiled, marked by faint spiral lirations. On the third the keels characteristic of the adult shell make their appearance; in addition to the keels there are many fine spiral lirations. The adult shell is marked by three spiral keels between the sutures, of which the peripheral one is by far the strongest. The two supra-peripheral keels divide the space between the sutures into three areas, of which the one immediately below the summit is a little wider than the other two, which are equal in width. The space between the summit and the first keel forms a sloping shoulder. In addition to the three keels, the whorls are marked by numerous microscopic, minutely granulose spiral lirations and moderately strong incremental lines between the sutures. Periphery of the last whorl angulated. Base well arched, narrowly umbilicated, marked by lines of growth and many fine, wavy, equally developed, and equally spaced finely wrinkled spiral lirations. In some specimens the area adjoining the umbilicus is moderately excavated, in others it is almost closed. Aperture suboval, bluish white within, edged with a dark-brown border; outer lip thin, rendered slightly sinuous by the keels; columella moderately strong, concave, and slightly reflected; parietal wall covered with a thick callus in adult shells, which is bluish white, with a dark border, and lends the peritreme a complete aspect.

In adult shells the last whorl is usually somewhat deflected below the peripheral keel of the preceding turn, and the keel is thus exposed above the suture. Operculum reddish brown, with scarcely depressed eccentric nucleus and many fine lines of growth.

The specimen figured probably had seven and a half whorls (the early ones being somewhat eroded) and measures: Altitude, 32 mm.; greater diameter, 24.5 mm.; lesser diameter, 21.1 mm.; aperture, altitude (from the posterior angle to the base of the columella), 17.4 mm.; diameter (at right angles to the last from the middle keel of the outer lip), 13 mm. There are eight specimens of this species in the collection of the U. S. National Museum—three, Cat. No. 103669, from Luzon, Philippine Islands, of which one has served for our description and figure; Cat. No. 104056b, one specimen, collected by Rich in Luzon; one, Cat. No. 47996, collected by Hungerford at St. Cruz Bay Lake, Luzon, and three specimens, Cat. No. 19985, obtained by the North Pacific Exploring Expedition at Manila, Luzon, Philippine Islands.

VIVIPARA ANGULARIS BURROUGHIANA Lea.

Plate X, figs. 3, 4.

Paludina burroughiana LEA, Trans. Am. Phil. Soc., V, 1837, p. 113, pl. XIX, fig. 80.

There are three specimens in the Lea collection, Cat. No. 105640, U. S. National Museum, which were collected by Doctor Burroughs at Manila, Philippine Islands. Since the types were collected by Doctor Burroughs at Manila, it is quite likely that these specimens represent the cotypes upon which Doctor Lea based his description. This appears all the more probable, as one of the three shells agrees in every respect with the figure cited above. *V. a. burroughiana* represents a strongly sculptured form of *angularis*. In this, the spaces between the keels on the spire are marked with a number of slender subgranose lirations. In some individuals these lirations attain almost half the size of the middle keel. The sculpture of the base also is much stronger than in *V. angularis* proper. There are five lots in the collection, the one cited above, of which one specimen is figured, Plate X, fig. 4, which measures: Altitude, 39.2 mm.; greater diameter, 28.2 mm. Cat. No. 19984, U.S.N.M., fifteen specimens, collected by Wilsoup at Manila. Of these eight are nepionic shells. Cat. No. 90477, one specimen, from Manila, the strongest sculptured individual, here figured. Plate X, fig. 3. Cat. No. 104056, U.S.N.M., one specimen, collected by Rich, in Luzon, Philippine Islands. Cat. No. 192975, U.S.N.M., four individuals, collected by Maj. Edgar A. Mearns, at Pasay Beach, Manila, Luzon, Philippine Islands.

VIVIPARA ANGULARIS PHILIPPINENSIS Nevill.

Plate X, fig. 2.

Paludina philippinensis NEVILL, Hand List Moll. Ind. Mus., 1884, p. 24. ?
Viripara hanleyi FRAUENFELD, Verz. Paludina, 1864, p. 618, for *P. intermedia*, Hanley, Ms., Reeve, fig. 57, 1863, Loc. ? (not of Deshayes).

Long. 23, diam. 19 mm. This is a very closely allied form to *P. javanica;* indeed, probably only a geographical race and perhaps would be better classed as a variety of it. It can nevertheless be readily distinguished by the keel on the last whorls, giving the suture a canaliculate appearance by the less developed spiral structure, by the presence of longitudinal, subobsolete plications, as also by its shorter and more decollated form, more convex whorls, the last one subangulate, darker and duller epidermis and blacker peristome, which is more or less angulate below.

Von Martens would not appear to have met with it, as it can not surely be the form he mentions, Mal. Blatt. 1865, p. 148, as a rounded keelless, extreme variety of *P. burroughiana.* One of my specimens approaches Reeve's fig. 53 (*P. carinata*), in the more rounded peristome and less distinct subangulation of the last whorl. Seven specimens, Majajay, Luzon; coll. R. Hungerford, esq.

The above are Nevill's remarks upon this form. Three specimens, Cat. No. 104056, U.S.N.M., one of which is here figured, agree with Reeve's figure 57 and also with the above remarks. *V. a. philippinensis* represents a form of *V. angularis*, in which the two supra-peripheral keels have become obsolete; the peripheral one alone remains, forming the peripheral angle. Its chief marks of distinction, however, lie in alternating narrow dark and light longitudinal bands, the first, the narrower, probably represent resting stages and are usually a trifle more elevated than the broader light areas, and lend the shell an obsoletely ribbed appearance. The spiral sculpture, consisting of fine granose spiral lines in *V. angularis*, is in the present form reduced to mere indications of microscopic spiral lines, the surface having a polished appearance. The color in the three specimens varies from light yellowish-green to dark olive-green ground, with narrow longitudinal brown bands. The specimens at hand, which also come from Luzon, force me to assign this form a place under *V. angularis.* The one figured measures: Altitude, 21 mm.; greater diameter, 17 mm.

VIVIPARA ZAMBOANGENSIS, new species.

Plate XI, fig. 19.

Shell conic, thin, dark olive green. Nepionic whorls one and one-half, well rounded, smooth. Succeeding turns somewhat inflated, marked between the sutures by three spiral keels, of which the basal one, which is a little stronger than the other two, marks the periphery. The two post-peripheral keels divide the space between the summit and the periphery of the whorls into three equal, almost flattened areas, which are marked by many very fine and somewhat wavy, spiral lines, that lend the surface a silky luster. The summit of the whorls falls immediately below the peripheral keel in all but the last turn; in this it is

deflected toward the base and a narrow band becomes apparent between it and the peripheral keel. Base rather short, well arched, narrowly umbilicated, marked by numerous fine, wavy, spiral striations as on the spire. Aperture small, subcircular; black edged, bluish white within; outer lip thin, faintly angled at the keels, columella thin, strongly concave and somewhat reflected over the slitlike umbilicus; parietal wall covered with a thick callus which renders the peristome practically continuous. Operculum reddish brown with depressed eccentric nucleus, marked by many incremental lines.

The type and fifty-four specimens, Cat. No. 192956, U.S.N.M., were collected by Maj. Edgar A. Mearns, at Zamboanga, Mindanao, Philippine Islands. The type has five whorls (the nucleus being eroded) and measures: Altitude, 25.9 mm.; greater diameter, 20.2 mm.; lesser diameter, 18.8 mm; aperture, altitude (from the posterior angle to the base of the columella), 13.1 mm.; diameter (at right angles to the last, from the middle keel of the outer lip), 11.5 mm.

A single much-worn individual, which is a little more slender than the shells from the type locality, was collected by Major Mearns in Libungan River at Labas, Rio Grande Valley, Mindanao, Philippine Islands.

VIVIPARA ZAMBOANGENSIS TUBAYENSIS, new subspecies.

Plate XI, fig. 16.

Shell similar to *V. zamboangensis*, but subglobose, with the whorl more inflated and with the secondary sculpture much more strongly developed. The six slender keels above the stronger peripheral one are of almost equal strength and the spaces between them are occupied by spiral lirations as in *V. zamboangensis*. The base also is more inflated than in *V. zamboangensis* and the umbilicus is completely closed. In color it is also entirely different, being light brown or yellowish brown. The sculpture of the present form bears the same relation to *V. zamboangensis* that *V. a. burroughiana* bears to *V. angularis*. The type, which has five whorls remaining (part of the nucleus being lost), measures: Altitude, 22.7 mm.; greater diameter, 20.1 mm.; lesser diameter, 18 mm.

The type and two specimens, Cat. No. 192974 U.S.N.M., were collected by Maj. Edgar A. Mearns in Tubay River at Santiago, Mindanao, Philippine Islands.

VIVIPARA ZAMBOANGENSIS DAVAOENSIS, new subspecies.

Plate XI, fig. 17.

This form resembles *V. z. tubayensis* in contour, but is much more delicate. It is flesh colored. The periphery is marked by a weak liration, while the rest of the surface is marked by many ill-defined,

closely spaced, fine, wavy, spiral lirations on the spire and the base. A few of these lirations are a little stronger and visible to the unaided eye. The sutures are strongly impressed and the well-rounded base is openly, narrowly umbilicated.

The type, Cat. No. 192976, was collected by Maj. E. A. Mearns at Davao, Mindanao, Philippine Islands. It has five and seven-eighths whorls and measures: Altitude, 21 mm.; greater diameter, 17.6 mm.; lesser diameter, 14.1 mm.; aperture, altitude (from the posterior angle to the middle of the base), 12 mm.; diameter (at right angles to the last, from the middle of the outer lip), 9.5 mm.

VIVIPARA ZAMBOANGENSIS SURIGENSIS, new subspecies.

Plate XI, fig. 18.

Shell resembling *V. z. daraganensis* in outline, but polished, periphery obsoletely angulated. The shell is of light olive green color, with a few narrow longitudinal brown bands at irregular intervals. Base well rounded, narrowly umbilicated. Under high magnification the surface of the spire and base show many very fine, quite closely spaced, wavy lirations, which are scarcely perceptible to the naked eye.

The type, Cat. No. 192977, U.S.N.M., was collected by Maj. Edgar A. Mearns in Baganga River, Surigao, Mindanao, Philippine Islands. It has five whorls and measures: Altitude, 16.4 mm.; major diameter, 15.3 mm.; lesser diameter, 13.4 mm.; aperture, altitude (from the posterior angle to the middle of the base), 10.4 mm.; diameter (at right angles to the last, at the middle of the outer lip), 8.5 mm.

VIVIPARA MINDANENSIS, new species.

Plate XI, fig. 11.

Shell subturreted, light olive green. The early whorls of the type are eroded, but it contained nine nepionic shells, one of which will serve for the description of the early turns. The largest nepionic shell has three and one-half volutions, the first two of which are more loosely coiled and more rounded than those that follow. They are all marked by exceedingly fine spiral striations. The periphery of the last whorl of the nepionic shell is strongly angulated, while the base is rounded like the spaces between the sutures and narrowly umbilicated. The adult whorls are inflated, evenly rounded at the side, but abruptly so near the summit, which renders this roundly tabulated. The periphery of the last whorl is marked by a moderately strong keel, while the space between it and the summit is crossed by six slender threads, which are not regularly spaced. In addition to these threads there are many exceedingly fine interrupted wavy spiral lirations between them. The summit of the whorls falls considerably below the peripheral keels and exposes this above the suture in all the

whorls. The summits of the whorls and the rounded shoulders are marked in addition to the above-mentioned sculpture with oblique wrinkles, which give this part of the whorls a quite strongly malleated appearance. Periphery of the last whorl angulated. Base short, somewhat inflated, well arched, excavated about the narrow open umbilicus and marked by ten subequal and irregularly spaced slender spiral lirations, between which there are many exceedingly fine interrupted papillose spiral lines. Aperture oval, bluish white within, bordered by a very narrow black edge on the outside; outer lip thin; columella concave, slender, somewhat expanded at the base and slightly reflected over the umbilicus; parietal wall covered with a thin callus; operculum orange, with depressed eccentric nucleus marked by many lines of growth. The type and seven specimens, Cat. No. 192559, U.S.N.M., were collected by Major Mearns in Lake Lanao, Mindanao. It has lost the first two nuclear whorls. The five which remain measure: Altitude, 31.1 mm.; greater diameter, 24.1 mm.; lesser diameter, 22 mm.; aperture, altitude (from the posterior angle to the middle of the base), 15.3 mm.; diameter (at right angles to the last, from the middle of the outer lip), 12.5 mm.

VIVIPARA MINDANENSIS BAGANGENSIS, new subspecies.

Plate XI, fig. 12.

Shell much more globose than *V. mindanensis*, dark olive green, with a reddish tinge. Interior of aperture reddish brown. Spire and base marked by more or less equally spaced fine spiral lirations and weakly developed obliquely forward slanting folds, which lend the last two turns a malleated appearance. In addition to the spiral lirations visible to the unaided eye there are many closely spaced, more or less interrupted, very fine, wavy lines which can be seen under the microscope. Base well rounded and narrowly umbilicated.

The type, Cat. No. 192979, U.S.N.M., was collected by Maj. E. A. Mearns in Baganga River, Surigao, Mindanao. It has six whorls (the first being decidedly worn) and measures: Altitude, 22.8 mm.; greater diameter, 19.3 mm.; lesser diameter, 17 mm.; aperture (from the posterior angle to the base of the columella), 18.8 mm.; diameter (at right angles to the last, at the middle of the outer lip), 10.3 mm.

VIVIPARA BULUANENSIS, new species.

Plate XI, fig. 15.

Shell thin, subturreted, broadly conic, light brown, shining. All the whorls inflated and well rounded, with a broad rounded shoulder at the summit. Sutures strongly impressed. Periphery of the last whorl with a mere indication of an angulation. Base short, well rounded, rather broadly openly umbilicated. The entire surface, both on the spire and on the base, marked by many moderately strong lines of growth, and many fine equally developed and subequally spaced

wavy spiral lirations. The crossing of these two elements lend the shell a finely reticulated sculpture. Aperture, moderately large, oval, white, with a brownish tinge within; outer lip, thin; columella very slender, somewhat expanded at base and slightly reflected; parietal wall covered with a short, thin, semitransparent callus. Operculum reddish orange, with but slightly depressed eccentric nucleus and many lines of growth.

The type and 136 specimens, Cat. No. 192978, U.S.N.M., were collected at Lake Buluan, Mindanao, Philippine Islands, by Maj. Edgar A. Mearns. The type has six and one-half whorls and measures: Altitude, 30.8 mm.; greater diameter, 23.3 mm.; lesser diameter, 28.8 mm.; aperture (from the posterior angle to the middle of the base), 15.2 mm.; diameter (at right angles to the last from the middle of the outer lip), 12 mm.

This entire lot is remarkably uniform in shape and sculpture, differing only in color, in which there is a variation from light olive green to reddish brown.

VIVIPARA CARINATA Reeve.

Plate XI, fig. 14.

Paludina carinata Reeve, Conch. Icon., XIV, 1863, no. 53, fig. 53.

The name of the present shell is somewhat misleading, since the carination is restricted to the periphery of the early whorls. In the adult turns it is quite obsolete.

The shell is conic and of olive-green color, with an occasional narrow, dark, longitudinal stripe. The early whorls are eroded in all of our specimens. The later ones are evenly rounded between the sutures, marked by lines of growth and exceedingly fine, closely spaced, obsolete, spiral lirations. Sutures strongly impressed. Periphery of the last turn obsoletely angulated. Base well rounded, with a narrow umbilicus, which is almost completely covered by the somewhat reflected columella, marked as the spire. Aperture moderately large, bluish white within, outer lip thin. Columella slender, concave, and somewhat reflected; parietal wall covered by a thin callus. Operculum reddish, with slightly depressed eccentric nucleus and many lines of growth. The specimen described and figured, Cat. No. 103666, U.S.N.M., has the apex badly worn. The six remaining turns measure: Altitude, 31.8 mm.; greater diameter, 25.2 mm.; lesser diameter, 23.4 mm.; aperture, altitude (from the posterior angle to the middle of the base), 18.6 mm.; diameter (at right angles to the last from the middle of the outer lip), 14 mm. Another specimen, belonging to the same lot, with worn nucleus and five whorls remaining, measures: Altitude, 22 mm.; greater diameter, 18 mm.; lesser diameter, 15 mm. These two individuals are marked Philippine Islands, without nearer designation of locality. Three additional specimens, Cat. No. 47995, U.S.N.M., were collected in Luzon, Philippine Islands, by Hungerford.

VIVIPARA CUMINGI (Hanley) Reeve.

Plate X, Fig. 7.

Paludina cumingi (Hanley) Reeve, Conch. Icon., XIV, 1863, no. 11, figs. 11, 11*a*.

Shell subglobose, of light olive green color. The early whorls are but little elevated, well rounded, marked by lines of growth and a few exceedingly fine interrupted spiral lirations. From the third whorl on the turns are decidedly inflated and strongly roundly shouldered at the summits, the shoulder being almost tabulated. These whorls are marked by faint lines of growth and exceedingly closely spaced, fine, wavy lirations. In additions to this sculpture a number of moderately strong, low, oblique, raised ridges make their appearance on the last two turns, which, in connection with the above-mentioned sculpture, give these whorls a weakly malleated aspect. Sutures strongly impressed. Periphery of the last whorl rounded. Base well rounded, narrowly unbilicated, marked by the lines of growth and obsolete spiral lirations as on the spire. Aperture moderately large, oval, bluish white, with a narrow dark-colored border; outer lip thin; columella slender, concave, somewhat reflected over the umbilicus; parietal wall covered with a thick, bluish white, dark-edged callus, which gives the peristome a complete aspect.

The specimen described and figured, Cat. no. 105658, was donated by C. M. Wheatley and comes from Luzon, Philippine Islands. It has five and one-half whorls and measures: Altitude, 17.1 mm.; greater diameter, 14.8 mm.; lesser diameter, 12.6 mm., aperture, altitude (from the posterior angle to the middle of the base), 10.2 mm.; diameter (at right angles to the last from the middle of the outer lip), 7.8 mm. Another specimen, Cat. No. 98070, U.S.N.M., was collected at Manila, Luzon, Philippine Islands, by W. W. Walpole.

VIVIPARA MEARNSI, new species.

Plate X, fig. 6.

Shell thin, polished, conic, strongly keeled at periphery, greenish-yellow, with irregularly disposed, narrow, dark, longitudinal bands, which appear to mark resting stages. The entire shell on the spire and base is marked by fine incremental lines and very fine, closely spaced, spiral striations, which lend the surface a finely reticulated aspect when viewed under high magnification. (Nuclear whorls decollated.) Succeeding turns well but not evenly rounded, the posterior half between the summit and the periphery being decidedly more convex than the anterior. Periphery of the whorls bearing a strong narrow compressed keel, which is apparent above the suture in all the volutions. On the earlier ones it is appressed quite closely to the summit of the succeeding turn, while in the last two volutions the

summit falls somewhat below the keel and makes this appear all the more prominent. Base short, evenly and strongly arched, with a narrow perforate umbilicus. Aperture ovate, rather large, the outer lip thin, rendered ⟨-shaped by the keel in the middle; columella slender, concavely curved; parietal wall covered by a thick callus which joins the columella and the posterior angle of the aperture, rendering the peristome complete. Operculum thin, translucent, reddish-brown, with depressed eccentric nucleus and well-marked incremental lines, the outer edge bearing a slight projection which fits into the angle of the peripheral keel.

The type and 58 specimens Cat. No. 192957, U. S. N. M., were collected by Maj. Edgar A. Mearns, at Lake Lanao, Mindanao, Philippine Islands. The type has five whorls (the nepionic part of the spire being lost) and measures: Altitude, 43.8 mm.; greater diameter, 36.3 mm.; lesser diameter, 32.5 mm. Aperture: Altitude (from the posterior angle to the middle of the base), 21.5 mm.; diameter (taken at right angles to the altitude at the keel of the outer lip), 17.2 mm.

Occasionally there appear one or more very slight spiral lirations on the surface of the spire; these, however, are not constant, even on the same shell, and therefore unimportant in the specific diagnosis.

This species is remarkably distinct from any of the recent Viviparas. It resembles V. yukotinovici Frauenfeld figured Plate 5, figs. 7, 8, in the Verh. Zool. Bot. Ges. Wien. XIV, 1864, which comes from the Neogentertiary of West Slavonia.

VIVIPARA MEARNSI MISAMISENSIS new subspecies.

Plate X, fig. 5.

Shell large, thin, subturreted, light olive green with many narrow dark brown bands, which coincide with the lines of growth and probably mark resting stages. Entire surface marked by rather strong incremental lines. Nuclear whorls wanting. Succeeding turns inflated, shouldered at the submit and marked by three prominent spiral ridges and two less conspicuous intermediate ones, between the sutures. The most strongly developed of these ridges is at the periphery, the next strongly developed one is located about two-fifths of the distance anterior to the summit, between the summit and the periphery, while the third is about halfway between these two keels. Of the two weaker cords, one stands halfway between the middle and posterior keel, while the other encircles the shoulder, about as far posterior to the first keel as the other intermediate cord is anterior to it. The spaces between these keels appear flattened and lend the outline of the whorls a polygonal appearance. Periphery of the last whorl strongly keeled. Base short, well arched, not umbilicated, marked by many fine rather closely spaced spiral lirations. Aperture suboval, white within, edged with black; outer lip thin, rendered

somewhat polygonal on its posterior half by the spiral cords; columella slender, decidedly concave and slightly reflected; parietal wall covered with a thick white callus which is black-edged like the lip and renderes the peristome continuous.

The type, Cat. No. 192960, U.S.N.M., was collected by Maj. Edgar A. Mearns in Lake Lanao, Mindanao, Philippine Islands. It lacks the nucleus and some of the earlier whorls, the last four only remain and these measure: Altitude, 31.7 mm.; greater diameter, 27.4 mm.; lesser diameter, 25.4 mm. Aperture: Altitude (from the posterior angle to the base of the columella), 18.5 mm.; diameter (at right angles to the last from the middle keel), 14.9 mm.

VIVIPARA PAGODULA, new species.

Plate X, fig. 8.

Shell thin, broadly conic, turreted, greenish yellow with irregularly disposed, narrow, dark bands coinciding with the lines of growth. Nepionic whorls decollated. Succeeding turns rather depressed, with a broad sloping shoulder above, which extends from the summit to the strongly keeled periphery. This shoulder is marked by two spiral lirations, which are placed a little to each side of the middle of the upper surface. The periphery is marked by a very strong, hollow keel, which falls about one-third of the distance anterior to the summit, from the summit to the base of the columella in the last turn. The space between the periphery and the summit of the succeeding turn is marked by two equally developed spiral keels, which are placed on the vertical side. The lower one of these is immediately above the suture, while the upper one is at some little distance below the periphery, which projects considerably beyond them. Base of the last whorl rather short, marked by the two strong spiral keels, which are rather closely spaced and enclose a narrow channel between them. The space between the posterior keel and the periphery is quite strongly concave. The space between the basal keel and the narrow, almost covered, umbilicus is well arched and marked by eight slender lirations, which are less strongly developed and more closely spaced about the umbilical area than at the keel. These lirations as well as the two basal keels are rendered faintly crenulate by the incremental lines. The spaces between the spiral keels and the lirations are marked by many exceedingly fine incised spiral striations, both on the spire and the base. Aperture slightly effuse basally, irregular in outline, the peripheral keel marking a deep acute angle and the two basal ones shallow rounded channels in the thin outer lip; columella slender, concave, and somewhat reflected over the umbilical opening; parietal wall covered with a thin callus.

The type, Cat. no. 192858, U.S.N.M., was collected in Lake Lanao, Mindanao, Philippine Islands, by Maj. Edgar A. Mearns, and has five and

one-fourth turns (the nucleus being lost), which measure: Altitude, 30 mm.; greater diameter, 26.5 mm.; lesser diameter, 22.4 m.: Aperture, altitude (from the posterior angle to the base of the columella), 15.9 mm.; diameter (at right angles to the last measurement at the basal keel of the outer lip), 13.3 mm.

VIVIPARA GILLIANA, new species.

Plate X, fig. 12.

Shell large, broadly conic, reddish brown. (First one and one-half whorls worn.) The second part of the second whorl shows the beginning of the sculpture of the adult turns, which consists of three poorly developed keels, of which one appears at the periphery and the other two between it and the summit. The space between the peripheral keel and the next one is a little narrower than the space between the median and posterior keel, while the space between the summit and the posterior keel is considerably wider still. The space between the summit and the posterior keel is moderately rounded and forms the shoulder of the whorl. The spaces between the other keels are flattened. The greatest convexity of the whorls is marked by the median keel. Periphery of the last whorl angulated. Base moderately long, strongly arched. The entire surface of the spire and base is marked by rather strongly expressed, incremental lines and many closely placed, microscopic spiral lirations. Aperture large, subcircular, reddish brown within; outer lip thin, rendered slightly angular by the keels; columella slender, concave, somewhat reflected over the umbilical area; parietal wall covered with a moderately thick dark colored callus. Operculum thin, yellowish, with decidedly depressed eccentric nucleus, marked by many lines of growth.

The type and five additional specimens (three of which are nepionic shells having the same sculpture as the adult turns), Cat. No. 192972, U.S.N.M., were collected by Maj. Edgar A. Mearns, in Lake Lanao, Mindanao, Philippine Islands. The type has five and one-half whorls and measures: Altitude, 37.4 mm.; greater diameter, 27.7 mm.; lesser diameter, 23.5 mm. Aperture, altitude (from the posterior angle to the middle of the base), 21.1 mm.; diameter (at right angles to the last, at the middle keel), 17.3 mm.

VIVIPARA LANAONIS, new species.

Plate XI, fig. 7.

Shell of medium size, decidedly turreted, olive-green with many narrow dark-brown bands which coincide with the rather strongly developed lines of growth. The largest young shell, taken from a specimen before birth, has four whorls, the first two of which are helicoid, well rounded, and marked by a few faint spiral striations,

while the two which follow bear the same sculpture as the adult shell, though less strongly developed. The whorls of the adult shell are very strongly tabulately shouldered, the shoulder terminating in a prominent compressed keel, which is located at about one-third of the distance between the summit and the base of the columella, anterior to the summit. This keel, which may be known as the peripheral keel, marks the widest part of the turn and overarches the rest. Between this keel and the summit of the succeeding whorl there are two additional keels which are a little less strongly developed. The basal one of these (the suprasutural keel) is immediately above the suture, while the other (the median keel) lies half-way between it and the peripheral keel. A fourth keel, which is considerably less developed than any of the three others, is situated on the shoulder, about as far posterior to the peripheral keel as the first one below the peripheral keel is anterior to it. Base of the last whorl rather short, well arched, marked by about eight subequal spiral lirations, which are a little more closely spaced and less strongly developed near the umbilical chink than away from it. Aperture irregular, bluish white within, with dark border; outer lip thin, rendered sinuous by the keels; columella slender, concavely curved; parietal wall covered with a moderately thick, bluish white callus, which is dark edged and gives the peritreme a complete aspect. Operculum thin, orange colored, with depressed eccentric nucleus and many lines of growth.

The type, which has lost the first two nepionic turns, has five whorls left, which measure: Altitude, 24.5 mm.; greater diameter, 17.4 mm.; lesser diameter, 15.4 mm.; aperture, altitude (from the posterior angle to the base of the columella), 11.6 mm.; diameter (at right angles to the last, from the middle keel of the outer lip), 9 mm.

The present species, while fairly constant as far as general outline is concerned, nevertheless presents considerable variations in sculpture. These variations appear to follow certain definite lines, which will be noted below. It is an interesting fact that in all the gravid specimens examined, the nepionic shells taken from the parent, always had the sculpture of the parent. There are 104 shells which belong to this species, all collected by Major Mearns, in Lake Lanao, Mindanao, Philippine Islands. Eleven of these belong to the typical form, which is entered as Cat. No. 192363, U.S.N.M.

Form alpha (Plate XI, fig. 8).—Differs from typical *lanaonis* in having the base smooth. There are six specimens of this form. Cat. No. 192364, U.S.N.M.

Form beta (Plate XI, fig. 2).—Has two slender cords between the peripheral and suprasutural keel, instead of a single median one. There are only two specimens of this type. Cat. No. 192365, U.S.N.M.

Form gamma (Plate XI, fig. 4).—This lacks the keel on the shoul-

der. There are eleven specimens of this form. Cat. No. 192366, U.S.N.M.

Form delta (Plate XI, fig. 10). –This lacks the median keel. There are four specimens of this form. Cat. No. 192367, U.S.N.M.

Form eta (Plate XI, fig. 9). This lacks the median and shoulder keel. There are thirty-two specimens in the lot. Cat. No. 192368, U.S.N.M.

Form theta (Plate XI, fig. 1).—Has same number and arrangement of the keels as in the typical form, but they are only weakly developed; the peripheral one is not stronger than the rest and does not overhang them. There are twelve specimens of this form. Cat. No. 192369, U.S.N.M.

Form iota (Plate XI, fig. 5). –Like theta, but lacking the cord on the shoulder. There are seven specimens in the lot. Cat. No. 192370, U.S.N.M.

Form kappa (Plate XI, fig. 3).—All the cords lost, except faint angles marking the peripheral and suprasutural keels. Nineteen specimens. Cat. No. 192371, U.S.N.M.

Form lambda (Plate XI, fig. 6).—In this form the periphery is angulated and the two supraperipheral keels are merely indicated; base smooth. One specimen. Cat. No. 192973, U.S.N.M.

VIVIPARA POLYZONATA Frauenfeld.

Plate XI, fig. 13.

Vivipara polyzonata FRAUENFELD, K. K. Zool. Bot. Ges. Wien, 1862, p. 2.

Shell conic, thin, with the apex flesh colored, the ground color of the rest olive green, while the spiral keels are dark brown. The first three whorls are helicoid and smooth excepting a few spiral striations. With the beginning of the fourth, the characteristic sculpture of the adult whorls makes its appearance, though at first this is merely indicated. The adult whorls are encircled between the sutures by three equally strong, well-rounded dark-brown cords of which the third is at the periphery and is just covered by the summit of the succeeding turns, though in the last half of the last turn it is left exposed. The other two keels divide the space between the peripheral keel and the summit into three equal spaces. The first of these spaces forms a moderate shoulder. An additional slender brown spiral cord, which is only about one-fifth as strong as the others is located a little nearer the first keel than the suture. Base of the last whorl rather short, well arched, without umbilicus, marked by a number of spiral keels which gradually diminish in size and become closer spaced from the periphery toward the umbilicus chink. One of the specimens has seven quite regularly spaced basal cords. Another has five less regularly dis-

tributed, while a third has only four cords. The entire surface of the shell, in addition to the keels is marked with fine lines of growth and many exceedingly fine spiral striations, the latter occurring between the keels. Aperture suboval, bluish white within, edged with dark brown; outer lip thin, rendered sinuous by the spiral keels; columella moderately thick, glazing the umbilical area; parietal wall covered with a moderately thick bluish white callus, which is edged with dark brown and lends the peritreme a complete appearance. Operculum light orange, thin, with depressed, eccentric nucleus, marked by many lines of growth.

The three specimens before me agree in size and sculpture, two, Cat. No. 105636, U.S.N.M., come from Manila, Luzon. One of these has seven whorls and measures, altitude, 19.9 mm.; greater diameter, 9 mm.; lesser diameter, 12.7 mm. Aperture, altitude (from the posterior angle to the base of the columella), 11 mm.; diameter (at right angles to the last, from the middle keel of the outer lip), 6.4 mm. The third specimen, Cat. No. 41125, U.S.N.M., was collected by Benson and donated by McAndrew. It bears the locality label, Philippines, and probably comes from Luzon, the type locality of the species.

VIVIPARA MAINITENSIS, new species.

Plate X, figs. 9, 10, 11.

While the collection contains no less than forty-three specimens of this species, there is not one of the adult shells which is perfect. It has been deemed advisable therefore to base the specific diagnosis upon several cotypes rather than a single imperfect individual.

Shell subglobose, with multisulcate spire and of light brown color. (The description of the first four whorls is based upon the juvenile specimen.) The first two and a half whorls helicoid, well rounded, rather loosely coiled. The first one marked by a few transverse wrinkles only. On the second one a few faint spiral lirations are apparent as well as weak lines of growth. On the first half of the third turn these lirations become stronger and are granulose, while on the second half of the same turn three conspicuous spiral keels make their appearance. These keels and the spaces between them are marked by many closely-spaced, fine, finely papillose lirations. The fourth whorl bears five very strong rounded keels above the periphery which are equally well developed and equally spaced. Periphery marked by a depressed sulcus, which bears a low, well-rounded keel in the middle, which is about one-half as wide as the first supra and infra peripheral keel. The peripheral sulcus in reality is not a sulcus but a keel less raised than the two which bound it. The base of the fourth whorl is well rounded and marked by low, almost flattened, closely spaced cords, of which there are two kinds, narrow and broad, the latter about three times as wide as the former and alternating with

them. There are about twenty-four cords on the base; they gradually become narrower from the periphery to the umbilical chink. These cords are marked by spiral lines of very minute papillae.

Second cotype.—Fifth and sixth whorls inflated, marked by six strong, moderately rounded cords between the summits and the peripheral sulcus. The first of these, at the suture, is considerably broader than the rest, and somewhat flattened, forming a narrow shoulder. The sutural keel is very low and ill-defined, in places bifed. Base not perforated; inflated and well rounded, marked by irregularly developed keels, which become quite obsolete from the middle of the base to the umbilical region. Aperture rather small, suboval, bluish white within; outer lip thin, faintly wavy, columella moderately thick, concave; parietal wall covered with a thin callus. Operculum reddish yellow, with slightly depressed eccentric nucleus, marked by numerous lines of growth.

Third cotype.—This is a badly eroded and fragmentary shell. It has at least one whorl more than the second cotype, i. e., about seven. This last turn has a decidedly tabulated shoulder and six rather rugose spiral keels between the shoulder and the obsolete peripheral sulcus. The base is likewise marked by rugose spiral keels. The keels are rendered rugose by the strong almost riblike incremental lines, which grow stronger as the shell increases with age.

The three cotypes have the following number of whorls and measure: First, young, has a little more than four turns, nucleus complete; altitude, 9.2 mm.; greater diameter, 8.4 mm.; lesser diameter, 7.8 mm.

The second cotype has five whorls (it has lost probably one and one-half), and measures: Altitude, 29.6 mm.; greater diameter, 24.5 mm.; lesser diameter, 21.3 mm. Aperture, altitude (from the posterior angle to the base of the columella), 16.8 mm.; diameter (at right angles to the last, from the insertion of the columella), 13.3 mm. The third cotype must have had about seven and a half whorls, six of which are still visible; it measures: Altitude, 37.1 mm.; greater diameter, 31.5 mm.; lesser diameter, 28.4 mm.

All of the specimens, 42, Cat. No. 192962, U.S.N.M., were collected by Maj. E. A. Mearns in Lake Mainit, northeastern Mindanao, Philippine Islands. One, Cat. No. 192961, U.S.N.M., comes from Baganga River, southeastern Mindanao, Philippine Islands.

There are two young individuals in the collection, Cat. No. 192980 U.S.N.M., collected by Maj. E. A. Mearns at Lake Mainit, Mindanao, Philippine Islands, which do not belong to any of the species of which we have adults from that locality. They are broadly conic, with the first one and one-half turns cylindrical, forming a mucronate apex. The periphery is strongly keeled and the shining surface marked by exceedingly fine closely spaced spiral lirations.

EXPLANATION OF PLATES.

[All figures are natural size.]

PLATE X.

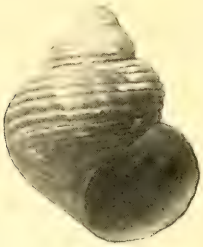
FIG. 1. *Vivipara angularis* Müller, p. 135.
2. *Vivipara angularis philippinensis* Nevill, p. 137.
3. *Vivipara angularis burroughiana* Lea, p. 136.
4. *Vivipara angularis burroughiana* Lea, p. 136.
5. *Vivipara mearnsi misamisensis* Bartsch, p. 143.
6. *Vivipara mearnsi* Bartsch, p. 142.
7. *Vivipara cumingi* (Hanley) Reeve, p. 142.
8. *Vivipara pagodula* Bartsch, p. 144.
9. *Vivipara mainitensis* Bartsch, p. 148.
10. *Vivipara mainitensis* Bartsch, p. 148.
11. *Vivipara mainitensis* Bartsch, p. 148.
12. *Vivipara gilliana* Bartsch, p. 145.

PLATE XI.

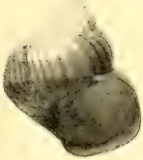
FIG. 1. *Vivipara lanaonis* form *theta* Bartsch, p. 147.
2. *Vivipara lanaonis* form *beta* Bartsch, p. 146.
3. *Vivipara lanaonis* form *kappa* Bartsch, p. 147.
4. *Vivipara lanaonis* form *gamma* Bartsch, p. 146.
5. *Vivipara lanaonis* form *iota* Bartsch, p. 147.
6. *Vivipara lanaonis* form *lambda* Bartsch, p. 147.
7. *Vivipara lanaonis* Bartsch, p. 145.
8. *Vivipara lanaonis* form *alpha* Bartsch, p. 146.
9. *Vivipara lanaonis* form *eta* Bartsch, p. 147.
10. *Vivipara lanaonis* form *delta* Bartsch, p. 147.
11. *Vivipara mindanensis* Bartsch, p. 139.
12. *Vivipara mindanensis bagangensis* Bartsch, p. 140.
13. *Vivipara polyzonata* Frauenfeld, p. 147.
14. *Vivipara carinata* Reeve, p. 141.
15. *Vivipara buluanensis* Bartsch, p. 140.
16. *Vivipara zamboangensis tubayensis* Bartsch, p. 138.
17. *Vivipara zamboangensis davaoensis* Bartsch, p. 138.
18. *Vivipara zamboangensis suriganensis* Bartsch, p. 139.
19. *Vivipara zamboangensis* Bartsch, p. 137.

1

5



9



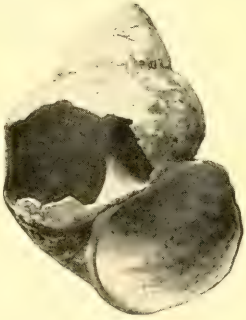
2

6

10

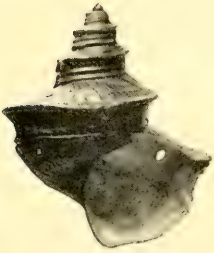
3

7



11

4

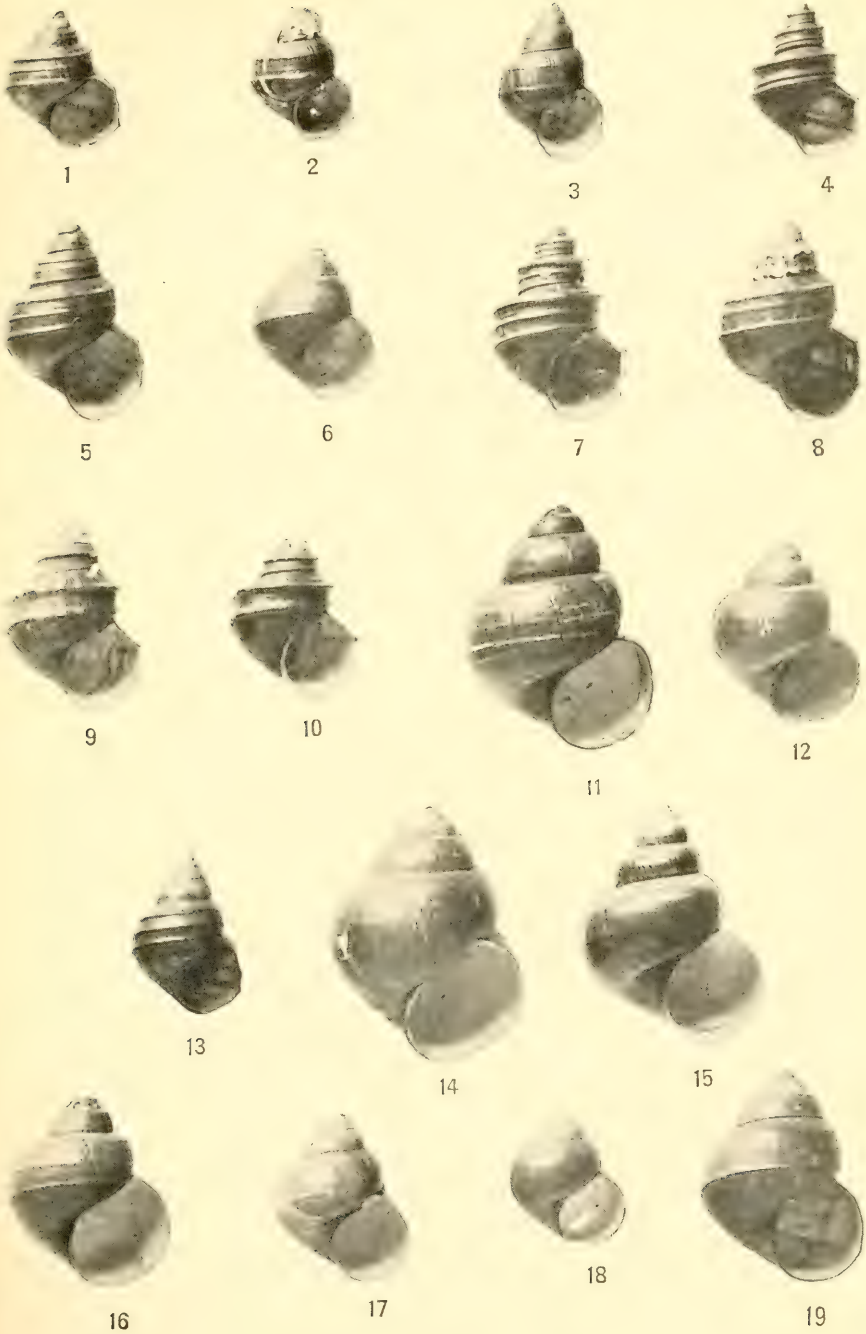


8

12

PHILIPPINE ISLAND VIVIPARIDÆ.

FOR EXPLANATION OF PLATE SEE PAGE 150.



PHILIPPINE ISLAND VIVIPARIDÆ.

FOR EXPLANATION OF PLATE SEE PAGE 150.

THE TYPE OF THE JURASSIC REPTILE MOROSAURUS AGILIS REDESCRIBED, WITH A NOTE ON CAMPTOSAURUS.

By Charles W. Gilmore,

Of the Department of Geology, U. S. National Museum.

INTRODUCTION.

In 1889[a] Prof. O. C. Marsh described briefly *Morosaurus agilis*, a new species of the Morosauridæ.

The type specimen (Cat. No. 5384, U.S.N.M.[b]) which was collected by Mr. M. P. Felch from the Upper Jurassic (Morrison Beds) of "Garden Park," near Canon City, Colorado, is now preserved in the fossil vertebrate collection of the U. S. National Museum.

The several elements comprising the type specimen were recently carefully prepared and important characters, hitherto unobserved because of adhering matrix, were disclosed. On account of the exceedingly brief original designation of this species, as well as new characters recently noted, the writer believes it of importance to describe and figure the specimen more in detail than was attempted by Professor Marsh.

REVIEW OF THE TYPE MATERIAL.

Marsh's original description of the species is as follows:

MOROSAURUS AGILIS, sp. nov.

A second new species, which apparently belongs to the same genus, is represented by the posterior half of the skull, the anterior cervical vertebræ, and other parts of the skeleton. This animal was in direct contrast with the one[c] last described, the skull and skeleton being especially light and delicate in structure for one of the *Sauropoda*. It was also much smaller in size, being the most diminutive known member of the genus, probably not more than fifteen feet in length.

[a] O. C. Marsh, Amer. Jour. of Sci., XXXVII, April, 1889, p. 334.

[b] Marsh's original accession numbers are as follows: 1607 and 12, 1904 catalogue number of the Yale University Museum.

[c] Marsh refers here to *M. grandis*, a larger species described in the same paper.

The figure below represents the back of the skull with the atlas attached, and the post-occipital bones in place. The axis and third cervical were also found in position. These will serve to distinguish the present species from the others of the genus, as they are proportionally much longer and of lighter structure.

The hind feet of the present specimen agree in general structure with those of *Morosaurus grandis*, but differ in having the first digit unusually large and massive in comparison with the others. The third, fourth, and fifth are especially slender.

The writer has been unable to find the "other parts of the skeleton" mentioned by Marsh in his original description. Moreover, a rough field sketch accompanying the type specimen only shows the posterior portion of the skull, atlas, axis, and third cervical, and these elements in all probability constitute the type specimen.

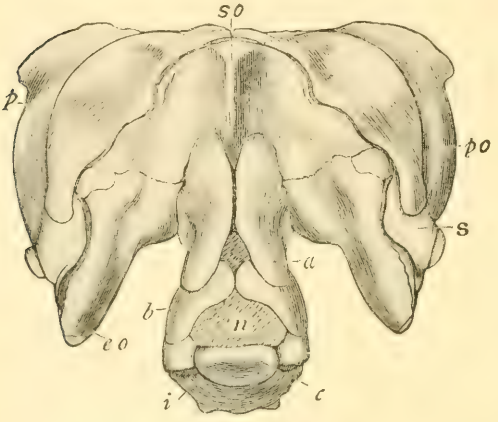


FIG. 1.—SKULL OF MOROSAURUS AGILIS (CAT. NO. 5384), POSTERIOR VIEW, $\frac{1}{8}$ NAT. SIZE. *a*, PROATLAS; *b*, LATERAL PLATE OF ATLAS; *c*, ODONTOID PROCESS, OR CENTRUM, OF SAME; *eo*, EXOCCIPITAL; *i*, INTERCENTRUM OF ATLAS; *n*, NEURAL CANAL; *p*, PARIETAL; *po*, POSTORBITAL; *s*, SQUAMOSAL; *so*, SUPRAOCCIPITAL.

The hind foot which is mentioned as appertaining to the "present specimen" is also missing, unless Marsh refers here to the right pes (Cat. No. 5369, U.S.N.M., 1655 Marsh's accession number, figured in Plate XXXVII, fig. 2, in Dinosaurs of North America), and which he has identified as belonging to *Morosaurus agilis*. See fig. 2*b*. Marsh must have inadvertently referred the pes to this species as the original field labels still with the specimens discussed here, show the type was collected in 1883, while the hind foot was not found until 1888, five years later. Fig. 1, Plate XXXVII, Dinosaurs of North America represents the right manus (Cat. No. 5371, U.S.N.M., Marsh's original number 1655) of *M. agilis*, also in the collection of this Museum. See fig. 2*a*. With the foot are the radius and ulna. Both of the feet were collected by Mr. Felch at the same time and place, "Garden Park," near Canon City, Colorado, from the Upper Jurassic (Morrison Beds), in 1888. Whether they belong to the same specimen or even to the same species, in the state of our present knowledge can not be determined with any degree of certainty.

The "quarry" at Canon City, where Marsh secured the remains of various specimens of the Dinosauria, is commonly known as a "general quarry," as from it have been obtained the remains of a large number of individuals representing several genera and species in a

disarticulated and scattered condition, so intermingled that, unless a skeleton has become isolated or is still articulated, the several elements composing it can not be reassembled with the absolute assurance that they pertain to a single individual. The writer is inclined to the opinion that the identification of the manus and pes of *M. agilis* has not been accurately made, and until we have more positive evidence it would be well to reserve our decision.

While Marsh pointed out in his original description that *M. agilis* is the most diminutive member of the Morosauridæ, from our present knowledge of the skeletal structure of the Opisthocœlian dinosaurs, the writer believes that his estimate of the length of *Morosaurus agilis*

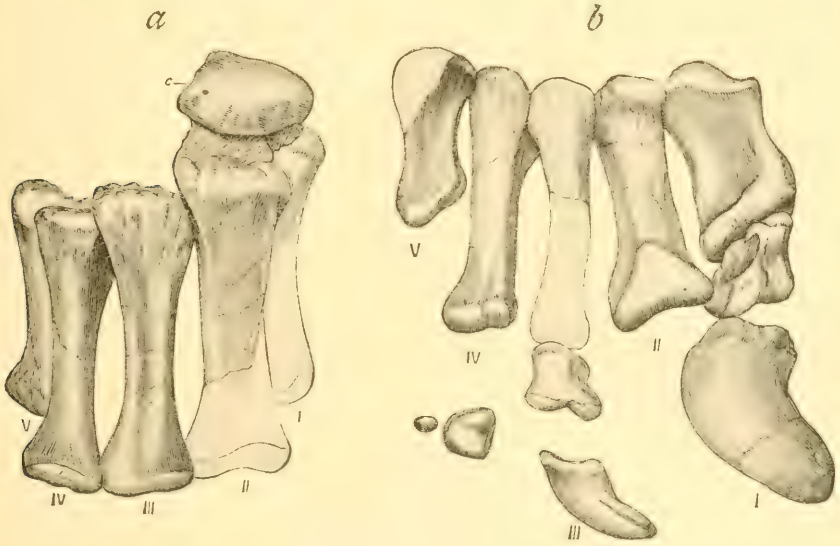


FIG. 2.—MOROSAURUS AGILIS? ¼ NAT. SIZE. *a*, FRONT VIEW OF RIGHT FORE FOOT (CAT. NO. 5371); *c*, CARPAL BONE; I–V, METACARPALS; *b*, FRONT VIEW OF THE RIGHT HIND FOOT; I–V, DIGITS (CAT. NO. 5369), ¼ NAT. SIZE.

at 15 feet would fall far short of the total length, and it would not be surprising were the skeleton found to exceed twice the original estimate.

DESCRIPTION OF THE TYPE SPECIMEN.

With the exception of two genera our knowledge of the skull of the Opisthocoelian dinosaurs is extremely limited. Recently Dr. W. J. Holland[a] has published a very complete description of the skull of *Diplodocus* based on all of the known material, and in a preliminary paper Prof. Henry F. Osborn[b] has mentioned some of the important

[a] W. J. Holland, Osteology of Diplodocus Marsh, Memoirs of the Carnegie Museum, Pittsburg, Pennsylvania, II, No. 6, 1906.

[b] H. F. Osborn, Nature, LXXIII, Jan. 18, 1906, p. 283, fig. 2.

features of a beautifully preserved skull of *Morosaurus grandis* now in the American Museum of Natural History, New York.

Although Marsh determined most of the elements composing the posterior aspect (see fig. 1) of the skull of *Morosaurus agilis*, he did not describe them in detail; therefore the writer, because of the rarity of the Opisthocoelian dinosaurian skulls, as well as to make our knowledge of these crania a little more exact, now attempts such a description.

DESCRIPTION OF SKULL.

The skull of *M. agilis*, although somewhat distorted by crushing, shows quite clearly the relationship of the several elements of the posterior portion. The occipital segment consists of four bones, basioccipital, exoccipitals, and supraoccipital, and the plane of the occiput forms an obtuse angle (see Plate XII) with the fronto-parietal part of the skull. The basioccipital extends well posterior to the median portion of the skull and forms the greater part of the subcircular convex condyle. Dorsally it unites by suture with the exoccipitals (see fig. 3). The latter bones enter into the formation of the occipital condyle and entirely exclude the basioccipital from the boundary of the foramen magnum. This arrangement of the occipital bones approximates the conditions found in the Chelonia. *Atlantosaurus montanus*, as figured[a] by Marsh, shows a similar arrangement of these elements.

The ventral side of the basioccipital in advance of the condyle is somewhat concave longitudinally and convex transversely, thus forming a well-defined neck. Anterior to this constriction a broad hypophysis begins to develop, being directed downward. Ventrally, however, this region has been badly injured, and the greater part of the basioccipital processes are missing. The suture between the basioccipital and basisphenoid is entirely obliterated.

The *exoccipitals* are not as broad nor as strongly developed as in *Diplodocus*, and they also differ in the backward extension of the basal portion for articulation with the basioccipital. The exoccipitals entirely enclose the foramen magnum and also enter into the formation of the occipital condyle. Laterally they articulate with the parietals and squamosals, the articulation with the latter being principally with the paraoccipital process which extends outward, backward, and downward. This process is expanded medially, but tapers to a rounded obtuse end. There are no posterior fossa in the skull of *Morosaurus agilis*. The suture at the union of the exoccipitals is entirely closed.

The *supraoccipital* is roughly an irregular subtriangular plate of bone occupying the space between the parietals above and the exoccipitals below. On the median posterior surface a very pronounced,

[a] O. C. Marsh, Dinosaurs of North America, Sixteenth Ann. Rept., U. S. Geol. Survey, Pt. 1, 1896, pl. xv, fig. 1.

somewhat roughened ridge is developed, which in *Diplodocus*, Doctor Holland has interpreted as the point of attachment for the nuchal ligament. Marsh has represented the suture between supraoccipital and exoccipital as continuing straight across toward the median line, but after removing the pro-atlas it was found to turn upward. (Compare figs. 1 and 3.) The further direction of this suture can not be determined from this specimen.

The *parietals* appear as two lateral processes extending from either side of the crest of the skull backward and downward, thus forming the anterior and inner lateral margins of the supratemporal fossa. The parietal suture is not indicated in this specimen. As shown by Professor Osborn in *M. grandis*, the parietals hardly enter into the composition of the roof of the cranium. Anteriorly they unite with the frontals, posteriorly with the supraoccipital which they enclose on three sides. At their posterior termination they overlap the squamosals. To a limited extent the parietal articulates with the exoccipitals. The great backward and downward extension of the parietals seem peculiar to this species.

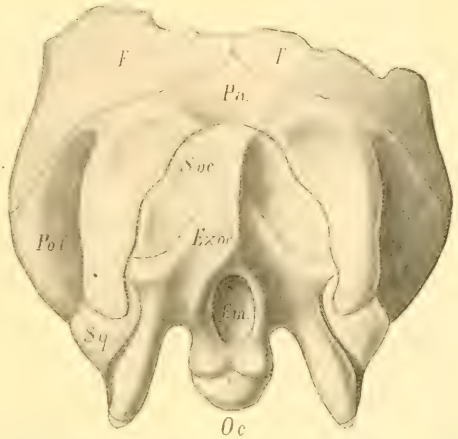


FIG. 3.—OBLIQUE POSTERIOR VIEW OF THE SKULL OF MOROSAURUS AGILIS (CAT. NO. 5384). ¼ NAT. SIZE. *Ex. oc*, EXOCCIPITALS; *F*, FRONTALS; *F. m*, FORAMEN MAGNUM; *O. c*, OCCIPITAL CONDYLE; *Pa*, PARIETALS; *Po. f*, POST FRONTALS; *S. oc*, SUPRAOCCIPITAL; *Sq.*, SQUAMOSAL. RIGHT SIDE RESTORED SOMEWHAT FROM THE LEFT.

Only a portion of the *squamosal* of the left side is preserved with this specimen. It forms the posterior boundary of the supratemporal fossa. Along its inner margin it articulates with the paraoccipital process of the exoccipital. Anteriorly it is overlapped by the posterior extremity of the parietal and externally it meets the postfrontal.

The *frontals* appear to be united on the median line by an interlacing suture. Over the orbital cavities the bone is thickened and the exterior margins somewhat roughened and rounded. Anteriorly and medially these bones thin out to a sharp edge. A broad process is sent out from the outer anterior margin which probably articulated with the prefrontal while the median part articulated with the nasals. The orbital surface is concave antero-posteriorly. Its inferior surface united by suture with the orbitosphenoid.

The element here designated by the writer as *postfrontal* is the one Marsh identified as the postorbital bone. (See fig. 1 *po.* and Plate

XII*po. f.*). He also omitted the suture between postfrontal and frontal, which is plainly shown on the specimen. (See Plate XIII.) While there is no positive evidence that the postfrontal is now correctly identified, yet after a comparison with other reptilian skulls, both fossil and recent, it appears to the writer the most logical arrangement of this region of the skull. The postfrontal at its anterior extremity articulates with the frontal and parietal, with the former by a long lapping suture. (See Plates XII and XIII.) Its inner margin constitutes the outer posterior boundary of the supratemporal fossa. At the posterior boundary of this fossa an inwardly directed expansion of this bone unites with the squamosal. Its anterior surface enters into the boundary of the orbital cavity.

The *basisphenoid* articulates posteriorly with the basioccipital and exoccipitals and laterally with the alisphenoids and orbitosphenoids. The basipterygoid processes are broken off and gone.

The *alisphenoid* and *orbitosphenoid* bones are present, but their boundaries can not be definitely defined at this time. Where the orbitosphenoid articulates with the ventral surface of the frontals are several notches or openings leading into the cerebral cavity.

OPENINGS IN THE SKULL.

The *foramen magnum* is wholly inclosed by the exoccipitals. The outline of the foramen has been distorted somewhat by crushing, but it appears higher than wide and was probably oval, as represented in the restored drawing. (See fig. 3.)

The *supratemporal* fossa is suboval in form and opens outward and backward. It is bounded anteriorly by the parietal and postfrontal; the inner wall is formed by the parietal and bounded posteriorly by the squamosal, its outer wall by the postfrontal.

Only the superior boundary of the *orbital cavity* is shown in this specimen. This is concave antero-posteriorly and is formed above by the frontal and postfrontal. The inner posterior wall is bounded chiefly by ali- and orbitosphenoids. See Plate XII*O. sp.* and *M. sp.*

There is no evidence of a *pineal foramen* in *M. agilis*. However, Marsh makes the following observation:[a] "In one specimen of *Morosaurus*, a similar opening has been observed, but in other *Sauropoda* the parietal bones, even if thin, are complete." He probably refers here to the skull of *Morosaurus grandis*, of which he figures a posterior portion in the Dinosaurs of North America. Plate XXX, fig. 2. The presence of a well-defined pineal foramen in the skull of *Morosaurus grandis* appears now to be definitely determined by Professor Osborn after a preliminary study of three *Morosaurus* skulls, of which he has published a figure of the more complete one.[b] He makes the

[a] Am. Jour. Sci., XXVII, February, 1884, p. 162.

[b] H. F. Osborn, Nature, LXXIII, 1906, p. 283, fig. 2.

following comments: "The most important point brought out is that all three skulls exhibit a well-defined tubular opening on top of the skull at the junction of the parietals and paraoccipitals. This foramen is smoothly lined with bone and leads directly down into the cerebral cavity."

Lesser foramina.—The brain cast of *Morosaurus grandis*, figured by Professor Marsh, shows at its anterior extremity the olfactory lobes. Just anterior to the place these lobes would occupy in the brain case of *M. agilis* is a large V-shaped opening, through which the olfactory nerves must have had exit. (See I, Plate XII.) The opening is bounded above by the frontals and below by the orbitosphenoids.

Twenty millimeters posterior to the olfactory foramen are two deep circular openings, the optic foramina. (See II, Plate XII.) These appear to merge into one another, but if separated at all it is by a very thin septum of bone. In *Diplodocus* Doctor Holland says they are separated by a "short filament of bone."

Posterior and external to the optic foramina, shown best on the right side of the skull, is a subcircular foramen, which probably gave exit to the oculomotor nerve. (See III, Plate XII.)

Situated at a higher level and posterior to the last-mentioned opening is an oval foramen (this is also best shown on the right side of the skull), which, according to analogy of the recent reptilia, is the exit for the trigeminal nerve. (See IV, Plate XII.)

As mentioned before, where the orbitosphenoids unite with the frontals along their superior lateral margins is quite a prominent foramen, which may have served as an entrance for blood vessels or the exit of nerves.

Just above the suture between exoccipitals and basioccipital and below the paraoccipital process in the exoccipitals are three foramina which the writer identifies as follows: The larger and superior one probably gave exit to the hypoglossal nerve; this opening passes through the exoccipital and enters the posterior margin of the foramen magnum a little in advance of its posterior boundaries. External to the hypoglossal foramen is the foramen for the pneumogastric nerves, while more ventrally still is the foramen through which the internal carotid artery enters the skull.

Pro-atlas.—The pro-atlas or postoccipital is composed of two subtriangular lateral pieces; when in position, as found with this specimen, they are attached to the occiput just above the foramen magnum, and extend backward and outward (see fig. 1, *a*, and Plates XII and XIII *P. At.*), overlapping the neural arches of the atlas, thus affording a protection to the spinal cord at this point.

These lateral pieces in profile are subtriangular, flattened, and somewhat curved antero-posteriorly. The anterior ends (see fig. 4*b*.) are greatly thickened and somewhat concave transversely, to better fit the

posterior surfaces of the exoccipitals with which they articulate. A notch and groove on the anterior end and side appear to indicate the course of a nerve. The internal surface of this bone is gently concave antero-posteriorly. The shaft gradually converges from the thick anterior to a thin posterior end.

Marsh has found the pro-atlas present in two members of the *Opisthocœlia* (*Sauropoda*), i. e., *Morosaurus* and *Apatosaurus* (*Brontosaurus*).[a] They have not been found in *Diplodocus*, although, after an examination of the posterior part of two skulls in the collection of this museum, a flattened roughened surface on the exoccipitals just above the foramen magnum would appear to indicate that these bones were also present in this genus.

The *pro-atlas* is often regarded as a vestige of a degenerate vertebra in front of the atlas, but Reynolds[b] says in the *Crocodilia* it is a membrane bone, and therefore not properly a vertebral element. In the crocodile these lateral pieces are united on the median line, thus forming a single element.

FIG. 4.—RIGHT HALF OF THE PRO-ATLAS OF MOROSAURUS AGILIS (CAT. NO. 5384), ½ NAT. SIZE. *a*, LATERAL VIEW; *b*, ANTERIOR END OF SAME.

Marsh has designated these elements in *M. agilis* as the "post occipital bones," but as they appear homologous with the dorso-lateral elements in *Rhynchocephalia*, certain *Lacertilia*, *Crocodilia*, *Pterosauria*, and *Chelonia*, to the writer there seems no good reason why the older term, pro-atlas, should not apply here.

Marsh gives the following measurements of the pro-atlas of *Morosaurus grandis:*

		mm.
	Greatest length	65
	Greatest length of surface opposed to exoccipital	30
No. 5384.	Greatest length proatlas of *M. agilis*	45
No. 5384.	Greatest length of surface opposed to exoccipital of *M. agilis*	27

Atlas.—The atlas is composed of four separate pieces, the intercentrum, two neural arches or neurocentra, and the odontoid process.

Like the atlas of *Diplodocus*, this element in *Morosaurus agilis* is short antero-posteriorly and without transverse processes. The pieces composing the atlas were found articulated, and although they have suffered somewhat from lateral compression (see fig. 5), there was not enough displacement to render it difficult to properly interpret them.

The *intercentrum* is, roughly, a moderately thick subcrescentic bone, both ends being truncated almost horizontally, thus forming two surfaces for articulation with the neural arches. The upper anterior surface is deeply excavated and well adapted for articulation with the

[a] E. S. Riggs, Field Columbian Museum Publication, p. 82, Geol. Ser., II, No. 4, Aug. 1, 1903. Riggs has shown that *Brontosaurus* is a synonym of *Apatosaurus*.

[b] S. H. Reynolds, The Vertebrate Skeleton, 1897, p. 240.

occipital condyle. Posteriorly it articulates with the odontoid and intercentrum of the axis. The median superior surface is concave transversely and somewhat convex antero-posteriorly. On either side of this median concave portion are broad articular surfaces upon which the pedicels of the neural arch rest. The somewhat roughened surfaces of these facets look upward and slightly outward instead of upward and outward, as Doctor Holland[a] has shown to be the case on the intercentrum of *Diplodocus*. The ventral surface is slightly concave antero-posteriorly and quite evenly rounded transversely. On either side of the median line of the posterior margin of the lower surface are small facets (see fig. 5 and also Plate XII*c*.), which represent the points of attachment for the cervical ribs. Just above these processes on the lateral surfaces the bone is somewhat excavated, forming two shallow pits.

The *neural arch*, or neurocentrum, is an irregularly curved bone, strongly concave inwardly and convex outwardly. It articulates with the intercentrum by means of a heavy articular base from which rises a broad, winglike plate. This articular end has three faces, one which unites with the intercentrum, a second large one which looks forward and inward and forms a part of the cup for the reception of the occipital condyle, and a third, the smallest of the three, which looks backward and inward and opposes the lateral anterior face of the odontoid. These faces all meet one another at obtuse angles. Above the articular end just described the shaft of the neural arch is constricted, but superior to this neck it widens out into a broad, thin, curved plate which, with the plate of the opposite arch, forms the covering of the neural canal. Where these plates oppose one another superiorly the ends are broadly rounded antero-posteriorly, though probably they never united, but were held together by ligamentary attachments. This plate, where it broadens anteriorly, terminates evenly in a thin, sharp, vertical edge, which is overlapped by the posterior extension of the pro-atlas. The posterior extent of the neurocentrum can not be determined accurately from this specimen, although the presence of anterior zygapophyses on the axis (see Plates XII and XIII*a*. *zyg*.) would indicate that the process continued far enough posteriorly to articulate with this surface.[b] Marsh's figure of the posterior view of the skull is apparently defective in this respect. (See fig. 1.) The *odontoid* or *pleurocentrum* has suffered considerably from crushing, but enough is preserved to determine its most important characters. The posterior articular face (see fig. 1*c*.) is

FIG. 5.—ANTERIOR VIEW OF ATLAS OF MOROSAURUS AGILIS (CAT. NO. 5384), ½ NAT. SIZE. *A. In*, INTERCENTRUM OF ATLAS; *n*, NEURAL ARCH; *o*, ODONTOID; *r*, RIB FACETS.

[a] W. J. Holland, Memoirs of Carnegie Mus., Pittsburg, II, No. 6, p. 247

[b] The posterior extension of this element in *M. grandis* is well shown in fig. 6.

slightly cupped and but little roughened, and in this specimen at least, shows no indication of coalescence with the axis. The anterior surface is rounded, not evenly, but somewhat constricted about the middle. The upper surface, which forms the floor of the neural canal, is slightly concave transversely.

Measurements of atlas.

	mm.
No. 5384. Greatest length of intercentrum	15
No. 5384. Greatest width of intercentrum	34
No. 5384. Greatest height of atlas	55

Axis.—The centrum of the axis is opisthocœlus and especially light and delicate in its construction. With certain modifications the centrum is concave longitudinally both on its lateral and ventral surfaces and convex transversely. The greatest length of the centrum is a trifle more than two-thirds the height of the vertebra from the ventral surface to the top of the neural spine. In these dimensions it differs from the axis of *M. grandis*, whose length of centrum is hardly more than one-half the height of the vertebra. (See fig. 6.)

FIG. 6.—SIDE VIEW OF AXIS AND PART OF ATLAS OF MOROSAURUS GRANDIS (No. 1905 YALE UNIVERSITY MUSEUM), ABOUT ⅓ NAT. SIZE. *a*, LEFT HALF OF NEURAL ARCH OF ATLAS; *b*, POSSIBLE INTERCENTRUM OF AXIS; *o*, ODONTOID PROCESS; *P. zyg*, POSTERIOR ZYGAPOPHYSIS.

On the left side is a deep pleurocentral cavity, the depth of which is probably somewhat exaggerated by crushing. This cavity is separated from the very shallow one of the opposite side by a thin septum of bone. Posteriorly this cavity is only separated from the cup for the ball of the succeeding vertebra by a thin convex plate of bone. Anteriorly it ends a little in advance of the center of the centrum. The anterior end of the centrum is gently rounded on either side. A vertical plate is developed behind, which is a cuplike excavation and lies in front of the pleurocentral cavity. On either side of the anterior ventral surface are what might be called infralateral cavities. These extend well forward into the ball of the centrum and are separated from one another by a thin median plate of bone. These cavi-

ties, the writer should judge from Hatcher's figures and description, are not present in the axis of *Diplodocus*, and they also appear to be absent in the axis of *M. grandis*. (See fig. 6.)

The anterior ventral surface of the centrum is abruptly truncated transversely, forming a broad, flat facet for the intercentrum of the axis. This element, so far as the writer has been able to ascertain, has never before been found in a member of the Opisothocœlia. In older individuals it may coalesce with the centrum and thus lose its identity. However, many of the sutures one would expect to find distinct in this individual have become entirely obliterated. The specimen of *M. grandis* described and figured by Marsh, which, according to the figures given, is a very much larger individual, shows sutures between the centra and spinous processes of the vertebræ. Yet in this very much smaller specimen there is no indication whatever of their union. So it would appear, as inferred by Marsh in his original description, that this is an adult representing the most diminutive member of the genus.

FIG. 7.—VENTRAL VIEW OF AXIS OF MOROSAURUS AGILIS (CAT. NO. 5384), ½ NAT. SIZE. *Ax. In.*, INTERCENTRUM OF AXIS; *P. zyg*, POSTERIOR ZYGAPOPHYSES; *Tr*, TRANSVERSE PROCESSES.

The second intercentrum (see fig. 7*Ax. In.*) is a small rectangular block of bone of greater width than length and of medium thickness, being thicker in front than behind. The posterior border is straight and fits closely to the truncated ventral surface of the centrum. It thus occupies a primitive position, as found in *Platecarpus*, and forms a liplike projection. An examination of Marsh's figure of the axis of *M. grandis* would indicate that it also bore an intercentrum, but in that case probably became completely co-ossified with the centrum. (See fig. 6*b*.) The anterior border is gently convex transversely. This element occupies the excavated surface of the centrum and does not extend below the lower surface. It is 22 mm. wide and 14 mm. long.

From the posterior and superior borders of the neural arch two diverging postzygapophysial lamina rise. These extend upward and backward until the postzygapophyses are reached; above them they continue upward and forward, meeting anteriorly and superiorly, forming the prespinal lamina. They thus inclose a deep postspinal cavity which opens posteriorly and superiorly. Prominent rugosities are developed just above the postzygapophyses. These also appear to be present on the axis of *Morosaurus grandis*.

A transverse process is developed on the anterior sides of the neural arch. It is moderately broad and thin and is directed downward, backward, and outward, terminating in a rounded end. The horizontal lamina extends from the transverse process to the postzygapo-

physes at an ascending angle. The inferior blade of the diapophysial lamina connects the transverse process with the side of the neural arch, thus forming the anterior wall of the postdiapophysial cavity. The pre- and supradiapophysial cavities are not present either in *M. agilis* or *M. grandis*. On the left side, just in front of the pleurocentral cavity, is a small foramen (*f*, Plate XII) which is wanting on the opposite side. The axis of *M. agilis* may be distinguished from that of *M. grandis* by the more anteriorly directed spine of the former, by the posterior extension of the postzygapophyses, and by the greater length of the centrum in proportion to its height. The writer believes that the cavities can not be considered sufficiently reliable characters for even specific separation, as they are not at all constant in shape, size, or position. Even on the same vertebra, as shown in this specimen, cavities found on one side may be absent on the other.

Measurements.

	mm.
No. 5384. Greatest length of centrum of axis	70
No. 5384. Greatest height of axis (taken at the middle)	97

Third cervical.—This vertebra was articulated with the axis, so its position may be considered absolutely determined. Like the other elements of the type specimen, it has suffered somewhat from lateral crushing. The transverse processes, postzygapophysial lamina, and postzygapophyses are wanting. This is the first vertebra of the vertebral column to have the anterior zygapophyses prolonged beyond the end of the ball of the centrum. Although the transverse processes are missing, a well-developed articular facet (see *r*, Plate XII) on the lower anterior margin of the centrum shows the place of attachment for the capitulum of the cervical rib.

The spinous process, as figured, has been crushed forward somewhat from its normal position. This spine anteriorly is a thin plate of bone formed by the union of the prezygapophysial lamina, but shows no indication of being bifid at its apex, as Hatcher has represented the spine on the third cervical of *Diplodocus*, or as the fourth cervical of *M. grandis* is known to be. The large pleurocentral cavities posteriorly are separated by a thin septum of bone, but anteriorly this partition fails and they become confluent. As in the axis, this cavity occupies the posterior half of the centrum. On the anterior part of the centrum just above the facet for the cervical rib is another lateral cavity, nearly round in outline and extending well into the ball of the centrum. There is also a prediapophysial cavity which is separated from the postdiapophysial cavity by the lower blade of the diapophysial lamina. This cavity is not present on the right side of the centrum.

Principal measurements.

	mm.
No. 5384. Greatest length of centrum of third cervical	95
No. 5384. Greatest height of third cervical	100

OCCURRENCE AND RELATIONSHIPS.

Of the five species Marsh has proposed under this genus, two (*M. grandis*[a] and *M. agilis*) were first known from the Jurassic of Colorado. The other forms (*M. impar*, *robustus*, and *lentus*), as well as *M. grandis*, have been found in the Jurassic of Wyoming. If Hatcher's suggestion proves correct—that the beds at Canon City, Colorado (from which Marsh obtained some of his type specimens), are the equivalent of the marine or Baptanodon beds of northern localities, and therefore represent a lower horizon of the Jurassic—it would be to this region that we would naturally turn for the ancestors of those species found in the higher beds of the Wyoming localities.

The small size, in addition to the presence of a second intercentrum on the axis and no evidence of bifurcation of the single spine of the third cervical of *M. agilis*, might suggest a somewhat primitive condition as compared with the later forms. This supposition, however, bears but little weight and is not substantiated by other paleontological evidence, as several genera and species of the Opisthocœlia, apparently identical, have been found in both regions, and it is quite probable that later we shall find that *M. agilis* enjoys a like geological and geographical distribution. Already Professor Osborn[b] has referred to a forefoot from the "Bone Cabin" quarry as possibly being *M. agilis*, but this is doubly doubtful since we are uncertain of the identification of the so-called forefoot of *M. agilis* by Marsh. Of the five species named by Marsh but few distinguishing characters have been given, and at this time little can be said regarding the relationship of the several forms.

The primitive characters found in *Morosaurus agilis* suggest to the writer the possibility that the type specimen, when more complete material is known, may be found to pertain to one of the members of the more primitive family Brachiosauridæ,[c] possibly the smaller genus *Haplocanthosaurus*.[d] Unfortunately, none of the representatives of this family have the anterior cervical region preserved; so judgment on the question raised here must be deferred until homologous parts are discovered. While the writer is aware of the close relationship of the Brachiosauridæ and Morosauridæ, the simple spine of the third cervical of *Morosaurus agilis* is particularly suggestive as to the possibility of its being a member of the former family.

---

[a] Williston has pointed out that *M. impar* and *grandis* are synonyms (Kans. Univ. Quart., VII, p. 173).

[b] H. F. Osborn, Bull. Am. Mus. Nat. History, III, 1899, p. 170.

[c] E. S. Riggs, Field Columbian Museum Publication, p. 94, Geol. Ser., II, No. 6, Sept. 1, 1904.

[d] J. B. Hatcher, Memoirs of Carnegie Museum, Pittsburg, II, No. 1, 1903.

A NOTE ON THE GENUS CAMPTOSAURUS.

In comparing the axis of *Morosaurus agilis* with the homologous parts of other Dinosaurian specimens in the U. S. National Museum, the writer found, on the axes of two individuals of the genus *Camptosaurus*, intercentra attached by suture to the centra of the axes. So far as the writer is aware, this element has not been observed before in a representative of the Orthopoda. In the smaller (No. 5474, U.S.N.M.) and probably younger specimen the intercentrum has been somewhat crushed out of position, but in the larger specimen (No. 5473, U.S.N.M.) it is retained in place, as shown in fig. 8 (*Ax. In.*).

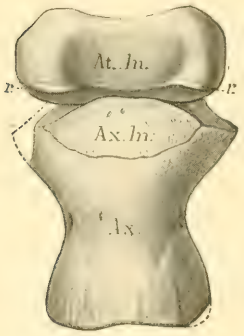


FIG. 8.—VENTRAL VIEW OF ATLAS AND AXIS OF CAMPTOSAURUS (CAT. NO. 5473), ½ NAT. SIZE. *At. In.*, ATLAS INTERCENTRUM; *Ax.*, AXIS; *Ax. In.*, AXIS INTERCENTRUM; *f.*, FACETS FOR RIBS.

Inferiorly the intercentrum of *Camptosaurus* is roughly subelliptical in form, the longer axis being transverse. It is closely united by suture to the lower half of the anterior end of the centrum, forming a prominent liplike projection which, when articulated, underlaps somewhat the intercentrum of the atlas. In a fully adult specimen this element would probably become co-ossified, as in *Morosaurus grandis*, and thus lose its identity. Viewed from the side, it is triangular in form, the deepest portion being next to the centrum. The inferior surface is gently convex transversely and slightly concave antero-posteriorly. Seen from the front, the center has the greatest vertical depth, the upper margins gradually sloping down to the lateral borders. The anterior face is smooth and somewhat concave supero-inferiorly. There are two small pits on the median anterior part of the inferior surface. The presence of an axis intercentrum in both the Opisthocœlia (Sauropoda) and Orthopoda (Predentata) tends to confirm somewhat the contention of Marsh and Hatcher that the Dinosauria is a natural group, and in the examples cited here it should be considered a persistent primitive character which was present in a remote but common ancestor.

FIG. 9.—ISCHIA OF MOROSAURUS; INFERIOR VIEW, $\frac{1}{10}$ NAT. SIZE. *c.*, DISTAL ENDS; *il.*, FACE FOR ILIUM; *p.*, DISTAL EXTREMITY; *pb.*, FACE FOR PUBIS; *s.*, SYMPHYSIS.

NOTE.

The writer takes this opportunity to call attention to fig. 3, Plate XXVIII, "Dinosaurs of North America" (reproduced here as fig. 9), which, according to Professor Marsh, illustrates the ischia of *Diplodocus longus*. After an examination of the original specimen, No. 4275,[a] now in the U. S. National Museum, it appears beyond question, as shown by the characteristic union of their distal ends, that these ischia pertain to the pelvis of one of the larger species of the Morosauridæ. The greatest length of the better preserved ischium is 800 mm.

EXPLANATION OF PLATES.

PLATE XII.

a.	Neural arch of atlas.	*O. sp.*	Orbitosphenoid.
Al. sp.	Alisphenoid.	*Pa.*	Parietal.
At.	Atlas.	*P. At.*	Pro atlas.
Ax.	Axis.	*Po. f.*	Postfrontal.
a. zyg.	Anterior zygapophysis of axis.	*r.*	Articular facet for attachment of cervical rib.
b.	Intercentrum of atlas.		
B. occ.	Basioccipital.	*S. F.*	Supratemporal fossa.
c.	Odontoid.	*S. oc.*	Supraoccipital.
d.	Intercentrum of axis.	*Sq.*	Squamosal.
Ex. oc.	Exoccipital.	*I.*	Olfactory foramina.
F.	Frontal.	*II.*	Optic foramen.
f.	Foramen.	*III.*	Oculomotor foramen.
O. C.	Occipital condyle.	*IV.*	Trigemenial foramen.

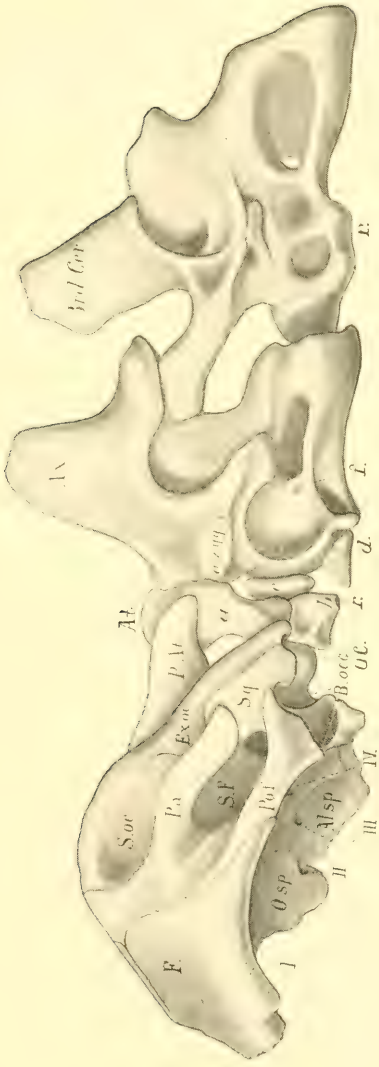
Side view of the posterior portion of the skull, the atlas, axis, and third cervical of *Morosaurus agilis*.

Type specimen (No. 5384) one-half natural size.

PLATE XIII.

Side view of the type of *Morosaurus agilis* (No. 5384), one-half natural size. From a photograph.

[a] Marsh's original accession number is 1655. The specimen is from the Morrison Beds of the Jurassic, near Canon City, Colorado.



SIDE VIEW OF NECK AND SKULL OF MOROSAURUS AGILIS.

FOR EXPLANATION OF PLATE SEE PAGE 165.

SIDE VIEW OF NECK AND SKULL OF MOROSAURUS AGILIS.

FOR EXPLANATION OF PLATE SEE PAGE 165.

NEW MOLLUSKS OF THE FAMILY VITRINELLIDÆ FROM THE WEST COAST OF AMERICA.

By Paul Bartsch,

Assistant Curator, Division of Mollusks, U. S. National Museum.

The United States National Museum has from time to time received additions to the collections of this family, among which are quite a number of undescribed forms. These are here diagnosed and figured.

VITRINELLA OLDROYDI, new species.

Shell small, sublenticular, semitransparent, a little more convex above than below. Nepionic whorls not differentiated from the rest, the entire upper surface smooth and shining, marked only by irregularly distributed incremental lines. The upper sides of the whorls are moderately and evenly rounded. Sutures well marked. Periphery of the last whorl well rounded. Base moderately well rounded, openly

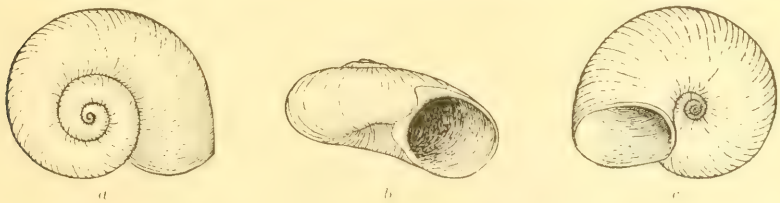


Fig. 1.—Vitrinella oldroydi. *a*, top view; *b*, side view; *c*, basal view.

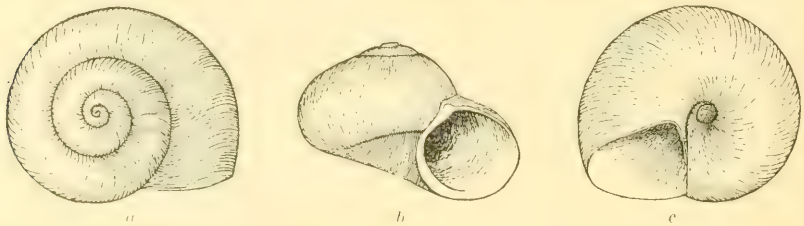
umbilicated to the very apex. Columellar wall of the base well rounded (not concaved). Aperture decidedly oblique, broadly oval; outer lip thin; columella decidedly curved and somewhat expanded at its insertion; parietal wall covered by a rather strong callus which partly fills the posterior angle.

The type, Cat. No. 158777, U.S.N.M., was collected in low water at Point Loma, California. It has three and three-fourths whorls and measures: Greater diameter, 2.1 mm.; lesser diameter, 1.6 mm.; altitude, 0.8 mm.

There are five additional lots in the collection of the U. S. National Museum: Cat. No. 127563, eleven specimens from San Pedro, California, collected by Mrs. T. S. Oldroyd; Cat. No. 192684, three from Terminal Island, California, collected by Mrs. W. H. Eshnaur; Cat. No. 60911, five specimens, collected by Mr. C. R. Orcutt, at San Diego, California; two, Cat. No. 183355, collected by Mr. Bailey, at La Jolla, California; and five, Cat. No. 105485, that were collected by Mr. H. Hemphill, at Point Abreojos, Lower California.

VITRINELLA ESHNAURI, new species.

Shell moderately elevated, subglobose, thin, almost transparent, glassy. Nepionic whorls 1½, scarcely differentiated from those which follow, well rounded, smooth. Succeeding whorls well rounded, somewhat inflated, marked only by exceedingly fine lines of growth. Sutures well impressed. Periphery of the last whorl well rounded. Base moderately rounded, marked only by incremental lines, with narrow but open umbilicus, which is obsoletely angled at the outer edge. Columellar wall of umbilicus vertical from the outer edge to



a *b* *c*

FIG. 2.—VITRINELLA ESHNAURI. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

within a short distance of the parietal wall, where it bends outward to join the preceding turn. Aperture decidedly oblique, almost circular; outer lip thin and translucent; columella quite strong and decidedly curved; parietal wall covered by a moderate callus which forms an acute angle with the posterior margin of the lip.

The type, Cat. No. 127557, U.S.N.M., was collected by Mrs. Oldroyd at San Pedro, California. It has 4⅛ whorls and measures: Greater diameter, 2.3 mm.; lesser diameter, 1.9 mm.; altitude, 1.3 mm.

Seven additional specimens were dredged by Mrs. Eshnaur at Terminal Island, California, three of which are entered under Cat. No. 192685, U.S.N.M., the remaining four being in Mrs. Eshnaur's collection.

VITRINELLA ALASKENSIS, new species.

Shell small, subglobose, semitransparent. Nepionic whorls 1⅓, well rounded, smooth. Succeeding turns somewhat inflated, well rounded, separated by strongly impressed sutures, marked only by incremental lines. Periphery and base of the last whorl well rounded. The latter

narrowly and openly umbilicated to the very apex. Columellar wall of the umbilicus not flattened nor angulated at the outer edge, but evenly rounded with the rest of the base. Aperture forming a broad semioval, of which the columellar side forms the short diameter; outer

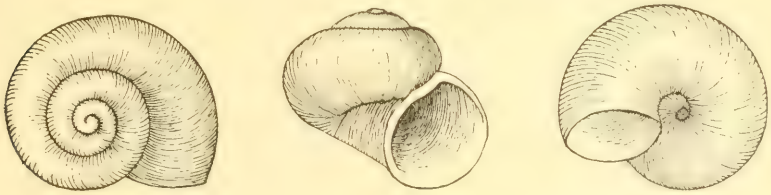


FIG. 3.—VITRINELLA ALASKENSIS. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

lip thin and semitransparent; columella slender and curved; parietal wall covered by a thin callus.

The type and eight additional specimens, Cat. No. 109470, U.S.N.M., were collected by Dr. William H. Dall at Unalaska, Alaska. The type has 3½ whorls and measures: Greater diameter, 1.6 mm.; lesser diameter, 1.2 mm.; altitude, 1.2 mm.

DOCOMPHALA, new subgenus.

Shell like typical *Vitrinella* except in the structure of the umbilicus. In *Vitrinella* ss. the columellar wall of the umbilicus is smooth. In the present group it is divided into two parts, the basal half of which is devoid of sculpture, excepting incremental lines, while the inner half is marked by strong, oblique, rounded ribs.

Type.—*Vitrinella* (*Docomphala*) *stearnsi*.

VITRINELLA (DOCOMPHALA) STEARNSI, new species.

Shell depressed, lenticular, a little more convex above than below. The nepionic portion of the shell consists of the first one and a half turns, which are small, slightly convex, and smooth. The turns which succeed the nepionic part of the shell are strongly, obliquely, transversely ribbed on the upper side, but these ribs gradually grow weaker as the shell increases in size and disappear entirely after one and one-half turns, the remaining portion being marked by mere lines of growth on the upper surface. Periphery of the last whorl well rounded. Base very gently rounded, crossed by rather strong incremental lines. Umbilicus wide and open to the very apex, decidedly angulated at the outer margin. The columellar wall is strongly concaved from the outer angulation to the junction with the preceding whorl, the inner half of it bears a series of strong ribs behind the aperture. Aperature decidedly oblique; outer lip acute, forming a regular semioval of which the parietal wall and columella form the short diameter; columella short, stout, concave; parietal wall covered

by a thick callus, which renders the peristome continuous and forms an acute angle with the outer lip posteriorly. The parietal callus and columella form a strongly sigmoid curve.

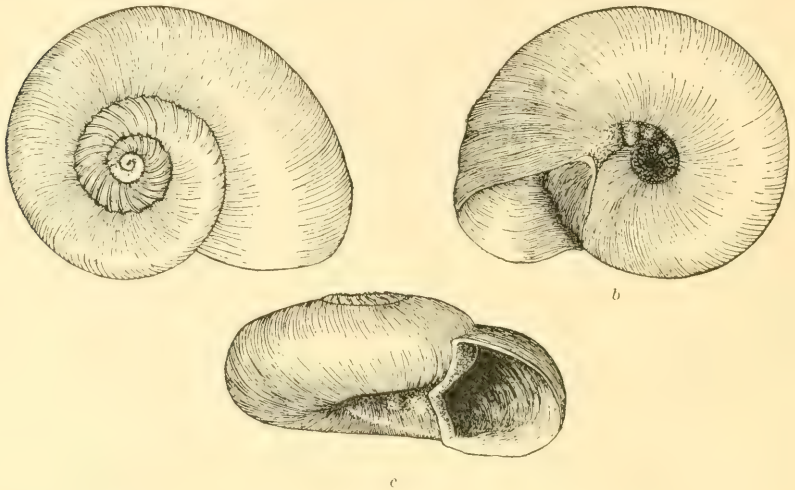


FIG. 4.—VITRINELLA (DOCOMPHALA) STEARNSI. *a*, TOP VIEW; *b*, BASAL VIEW; *c*, SIDE VIEW.

The type and three young individuals are part of the Stearns Collection and are entered as Cat. No. 74011, U.S.N.M., and come from Monterey, California.

The type has 4½ whorls and measures: Greater diameter, 3.8 mm.; lesser diameter, 3 mm.; altitude, 1.5 mm.

VITRINELLA (DOCOMPHALA) BERRYI, new species.

Shell small, semitransparent, lenticular, with the upper part only slightly more convex than the base. Nepionic whorls forming a little more than one and two-thirds turns, smooth, and moderately convex.

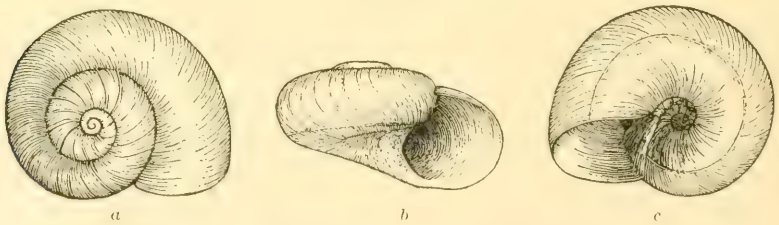


FIG. 5.—VITRINELLA (DOCOMPHALA) BERRYI. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

The portion following the nepionic part is crossed on the upper surface by quite regularly spaced, sublamellar riblets, which become weaker as the shell increases in size, and disappear completely after one and one-half turns; the remaining part of the upper surface being marked by weak incremental lines only. Sutures well marked. Periphery

of the last whorl well rounded, the first half showing continuations of the ribs, the rest being smooth. Base moderately rounded with a fairly strong spiral keel which is situated about one-third of the way toward the umbilical angle from the periphery. Umbilicus much narrower than *V. stearnsi*, its outer edge terminating in a blunt angle. Columellar wall decidedly concaved, the inner half marked by a series of strong riblike nodules as in *V. stearnsi*. Aperture decidedly oblique, subcircular; outer lip thin; columella very thick, concaved, provided with a moderately strong callus which bends back into the umbilicus.

The type, Cat. No. 192686, U.S.N.M., and another specimen in the collection of Mr. S. S. Berry were dredged by that gentleman in 12 fathoms, off Del Monte, Monterey Bay, California. It has 4 whorls and measures: Greater diameter, 2.2 mm.; lesser diameter, 1.7 mm.; altitude, 1 mm. Another specimen of this species, Cat. No. 192687, U.S.N.M., was collected by Mrs. T. S. Oldroyd at San Diego, California.

CYCLOSTREMA XANTUSI, new species.

Shell small, transparent, with moderately elevated spire. Nepionic whorls $1\frac{1}{8}$, well rounded, smooth. The succeeding turns are marked by a strong peripheral cord and another spiral cord which is situated

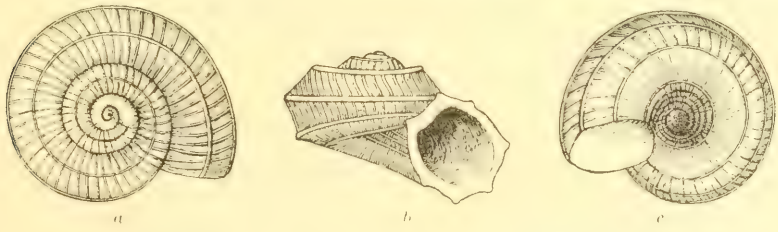


FIG. 6.—CYCLOSTREMA XANTUSI. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

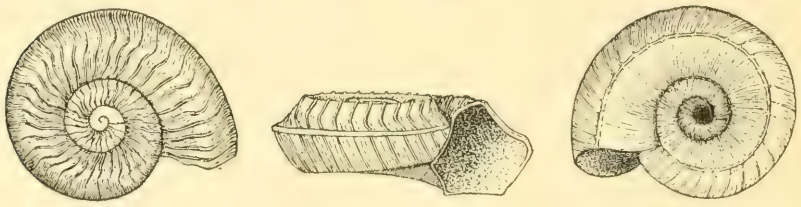
a little nearer the summit than the periphery of the whorls. In addition to this spiral sculpture there are many (about 48 on the last turn) regular, equally spaced, low riblets, which coincide with the lines of growth and are about one-third as wide as the spaces that separate them. Periphery of the last whorl strongly angulated by the spiral cord. The base is marked by three spiral keels—one at the edge of the umbilicus, the other two divide the space between this and the peripheral keel into three equal parts. The riblets of the upper surface continue equally strong over the space between the peripheral and the first basal keels, but between this and the second basal keel they become decidedly enfeebled, while they are almost absent between the second keel and the one that bounds the umbilicus. Umbilicus broadly open. Columellar wall of the last whorl well rounded and marked by three equally spaced spiral threads, the inner one of which is decidedly

weaker than the rest. Aperture decidedly oblique, polygonal, the angles being formed by the spiral keels, the posterior angle of the aperture, and the insertion of the stout and strongly curved columella.

The unique type, Cat. No. 4035, U.S.N.M., was collected by J. Xantus at Cape St. Lucas, Lower California. It has little more than four whorls and measures: Greater diameter 1.4 mm.; lesser diameter 1.15 mm.; altitude 0.5 mm.

CYCLOSTREMA DIEGENSIS, new species.

Shell exceedingly small, thin, planorboid, with a prominent, compressed peripheral keel, translucent, yellow horn-colored. Nepionic whorls 1½, moderately rounded, not elevated, smooth. The succeeding turns have their highest elevation at about one-third of the distance from the suture to the periphery, at which place they are raised into a broad, well-rounded ridge from which they slope abruptly, convexly rounded, to the suture and more gently concavely to the angulated periphery. On the upper surface the whorls are ornamented with slender, regularly spaced, oblique riblets, which are



a *b* *c*

FIG. 7.—CYCLOSTREMA DIEGENSIS. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

best developed on the elevated ridge, where they are about one-fourth as wide as the spaces that separate them. Sutures strongly marked. Periphery with a compressed, obtuse angle. Base moderately rounded, broadly openly umbilicated, with a slender thread bounding the outer edge of the umbilicus and a slender spiral cord situated about halfway between the umbilical thread and the periphery. The riblets seen on the upper surface extend feebly beyond the peripheral keel to the first basal cord but are reduced to simple incremental lines between this and the umbilical thread; columellar wall well rounded, marked by incremental lines only. Aperture oblique, irregularly pentagonal, one blunt angle being formed by the elevated part of the whorl, another equally obtuse one by the periphery, the third by the basal keel, the fourth by the umbilical angle, and the fifth by the junction of the columella with the parietal wall. Outer lip thin, showing the sculpture of the shell within. Columella straight and very obliquely placed. Parietal wall covered by a thin callus.

There are five specimens of this species in the collection of the U. S. National Museum, Cat. No. 105488, all from San Diego, California.

The type, which is one of these specimens, has $3\frac{3}{4}$ whorls and measures: Greater diameter 1.0 mm.; lesser diameter 0.8 mm.; altitude about 0.25 mm.

CIRCULUS COSMIUS, new species.

Shell decidedly depressed, planorboid, creamy white, shining. Nepionic whorls 2, well rounded, helicoid, polished. Succeeding turns marked by a low, rather broad spiral thread at the summit and a strong, acute, lamellar ridge at the periphery, and another equally strong halfway between the periphery and the summit. The last has the free edge pointing outward, forming an angle of 45° with the peripheral lamella. The spaces between these keels are gently rounded and marked by incremental lines only. The middle keel forms the most elevated portion on each whorl, the summit of the whorl at the suture being considerably lower. Base very broadly umbilicated, marked by a spiral, lamellar carina, which is as strong as the peripheral one and is situated halfway between this and the umbilical angle. In addition to this carina the entire base shows fine incremental lines.

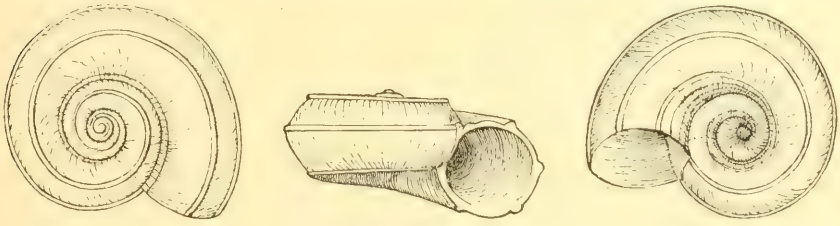


FIG. 8.—CIRCULUS COSMIUS. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

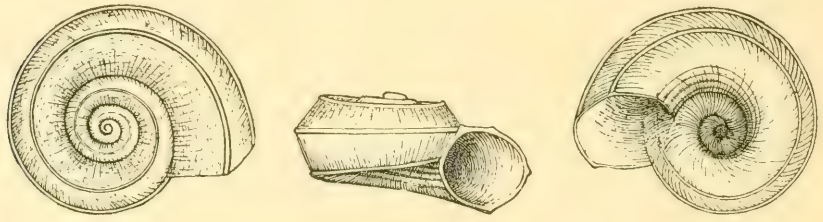
Umbilicus limited by an obtuse angle; columellar wall almost vertical, marked by three slender, equally spaced, spiral lirations. Aperture decidedly oblique, pentagonal, the angles being formed by the three carinæ, the posterior angle of the aperture, and the umbilical angle; outer lip thin; columella decidedly curved; parietal wall covered by a strong callus, which renders the peritreme almost continuous.

There are two specimens in the collection of the U. S. National Museum, Cat. No. 192708, both dredged by the U. S. Bureau of Fisheries steamer *Albatross*, at Station 2799, near Atacames, Ecuador, in $29\frac{1}{2}$ fathoms of water. The type, which is one of these two specimens, has $4\frac{1}{2}$ whorls and measures: Greater diameter, 2.5 mm.; lesser diameter, 2.1 mm.; altitude, 1 mm.

CIRCULUS CERROSENSIS, new species.

Shell decidedly depressed, planorboid, semitransparent, yellowish horn colored. Nepionic whorls 2, moderately elevated, polished. Succeeding turns marked by a feeble spiral thread at the summit and a strong, acute spiral lamella at the periphery and another equally strong

about halfway between the two. In addition to these keels the surface on the upper side is marked by many fine incremental lines and numerous equally fine spiral striations. The greatest elevation of the whorls falls in the region of the middle keel, from there they slope roundedly downward to the sutural thread. Base very broadly umbilicated, showing all the whorls within the umbilicus to the very apex. A strong spiral keel, somewhat stronger than the peripheral one, is situated almost halfway between the umbilical edge and the periphery. In addition the base is marked by fine incremental lines and scarcely perceptible spiral striations. The umbilical edge is marked by a moderately strong carina and the columellar wall, which is moderately rounded, bears immediately below this three equally spaced threads, the outer two of which are as strong as the carina at the edge, while the inner one is only feebly developed. Aperture extremely oblique, pentagonal, the angles being formed by the keels, the posterior angle of the aperture and the umbilical carina; outer lip thin; columella strongly curved; parietal wall with a faint callus.



a *b* *c*

FIG. 9.—CIRCULUS CERROSENSIS. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

The type and only specimen known, Cat. No. 151942, U.S.N.M., was dredged by the U. S. Bureau of Fisheries Steamer *Albatross* at Station 2827 off Cerros Island, Lower California, in 10 fathoms of water. It has 5 whorls and measures: Greater diameter, 2.5 mm.; lesser diameter, 2.1 mm.; altitude, 1.1 mm.

While this specimen resembles *C. cosmius* closely in general outline, it can nevertheless be distinguished quite readily by the fine spiral sculpture between the keels on the upper surface, which is absent in *C. cosmius* and by the much more strongly developed spiral cords on the columellar wall of the umbilicus.

CYCLOSTREMELLA CALIFORNICA, new species.

Shell small, planorboid, semitransparent, closely spirally striated. Nepionic whorls 1¼, moderately rounded, smooth and shining. Succeeding turns increasing regularly in size like Planorbis, rendering the apex considerably lower than any of the succeeding turns, the last being the most elevated. Whorls well rounded, separated by strongly impressed sutures and marked by many equally strong and equally

spaced, somewhat wavy, incised spiral lines and fine incremental lines. At more or less regular intervals there appear slight constrictions which coincide with the lines of growth. Periphery of the last whorl well rounded. Base well rounded, very broadly and openly umbilicate to the very apex, marked like the upper surface. Aperture oblique, suboval; outer lip thin; columella short, forming almost a straight line with the faint callus of the parietal wall. The type has a little more than three and a half whorls and measures. Greater diameter, 2.3 mm.; lesser diameter, 1.8 mm.; altitude, 0.8 mm.

The type and another specimen were collected by Mrs. Oldroyd at Long Beach, California, and are entered under Cat. No. 125537, U.S.N.M.

There are five additional lots in the collection: Cat. No. 192709, one specimen collected by Mr. S. S. Berry in 12 fathoms off Del Monte, Monterey, California; Cat. No. 127561 U.S.N.M., three specimens

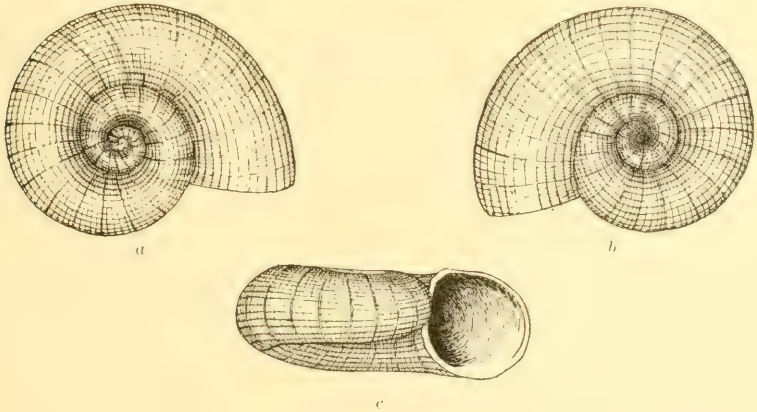


FIG. 10.—CYCLOSTREMELLA CALIFORNICA. *a*, TOP VIEW; *b*, BASAL VIEW; *c*, SIDE VIEW.

from San Pedro, California, collected by Mrs. Oldroyd; Cat. No. 192710, U.S.N.M., 25 specimens dredged at Terminal Island by Mrs. W. H. Eshnaur, and 50 additional specimens from the same place are in the collection of Mrs. Eshnaur; Cat. No. 192711, U.S.N.M., three specimens collected by Mrs. Oldroyd at San Diego, California; and lastly Cat. No. 7963, six fossil specimens collected by Mr. Henry Hemphill in the Postpliocene beds of San Diego, California.

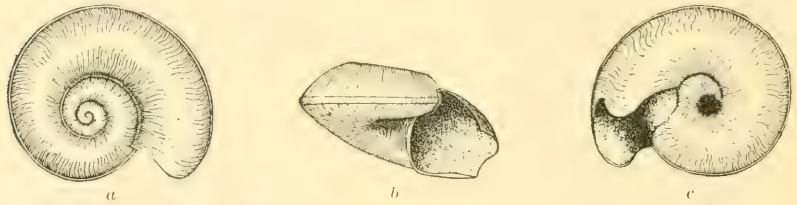
SCISSILABRA, new genus.

Vitrinella-like shells with the middle of the outer lip deeply and broadly notched, the center of the notch coinciding with the periphery of the shell.

Type.—Scissilabra dalli.

SCISSILABRA DALLI, new species.

Shell small, depressed, lenticular, with acutely angulated periphery, having 3½ transparent, vitreous whorls which are separated by well-marked sutures. The nepionic portion consists of the first 1⅝ turns and is scarcely differentiated from the rest of the shell. The upper surface is evenly and gently rounded from the summit to the periphery, which is strongly and sharply carinated. Under side openly umbilicated, much less convex than the upper. The umbilical edge is marked by an acute carina from which the columellar wall in the last whorl extends almost vertically to where it joins the preceding turn. This carina and vertical umbilical wall are characteristic of the last turn only; in all the others which are visible in the umbilicus it appears



a *b* *c*

FIG. 11.—SCISSILABRA DALLI. *a*, TOP VIEW; *b*, SIDE VIEW; *c*, BASAL VIEW.

evenly rounded. Aperture very large, decidedly oblique; outer lip very broadly and strongly notched, the blunt angle of the notch coinciding with the periphery of the shell; the portion of the lip posterior to the sinus and its basal part somewhat sinuous; columella vertical and slightly concave; parietal wall covered by a thick callus which renders the peritreme almost continuous.

The type, Cat. No. 192712 U.S.N.M., was collected in the beach drift, San Diego, California. It measures: Greater diameter, 2 mm.; lesser diameter, 1.5 mm.; altitude about 0.75 mm.

Another specimen, Cat. No. 127562, U.S.N.M., comes from San Pedro, California. A third specimen, Cat. No. 192713, U.S.N.M., was dredged in 12 fathoms, blue mud bottom, at Monterey Bay by Mr. S. S. Berry, and an additional specimen from the same locality is in Mr. Berry's collection.

MEASUREMENTS OF THE CRANIAL FOSSÆ.

By Aleš Hrdlička,

Assistant Curator, Division of Physical Anthropology, U. S. National Museum.

While there exists only a general correlation between the outside and the inside of the skull, the brain and the cranial cavity correspond under normal conditions exactly. The brain is separated from the skull only by the meninges, which, however, are of small and uniform thickness, and adhere everywhere closely to the organ as well as to the bone, so that the above statement is not affected.

The skull cavity presents certain subdivisions, known as cranial fossæ, which correspond with certain portions of the brain. These fossæ are termed the anterior, middle, and posterior, and the parts of the brain they inclose are the anterior, middle, and posterior lobes of the cerebrum, with the cerebellum. The two last named occupy the posterior fossa on each side, one its superior and the other its inferior portion. As the study of the brain is continually gaining in importance, one of the most valuable investigations on this organ would be a series of accurate measurements of its lobes; but the brain is soft, and before it can be measured must be hardened in preservatives. This, in the case of the heavy human brain, is seldom achieved without some flattening or other deformation. Measurements on a deformed organ can, however, never be accurate and can not be relied upon for any finer differentiations. Moreover, normal human brains are not easily obtained, even those of the whites, and in the case of many races, in which the study of the organ is most urgent, the material is extremely limited or wholly wanting. As a good example of this may be cited the North American Indian, whose brain has never yet been properly studied. There are now in the U. S. National Museum just three brains of these people, and all of them are so badly deformed or damaged as to be entirely unsuitable for measurement. Under such circumstances, and in view of the close correspondence of subdivisions of the brain with those of the skull cavity, it becomes desirable to utilize, so far as feasible, measurements on the latter and on its subdivisions. This has been attempted by the author, and the present report is the result of a limited number of the more important measurements.

Proceedings U. S. National Museum, Vol. XXXII—No. 1521.

This paper deals with the absolute and the relative lengths of the cerebral and cerebellar fossæ in man and a series of animals, and with the relation of the length of the different fossæ to the form of the skull.

The detailed objects of the study were the elucidation of how the several fossæ, or rather the parts of the brain which they limit, differ in the various races of mankind, in the two sexes, between the young and adults, between man and other mammals, and, finally, in dolicho- and brachycephaly.

A similar study of the cranial fossæ has not, so far as the writer was able to learn, been as yet attempted. General remarks on the size of the fossæ will be found in Cuvier;[a] Morton[b] measured the capacity of the "anterior" and "posterior" chamber of the skull, Huschke[c] and Aeby[d] the capacity of the frontal and occipital vertebræ, and Giuffrida-Ruggeri[e] that of the cerebellar fossa; finally a number of observers[f] have measured directly the several lobes of the brain; but linear measurements of the fossæ are wanting. Yet these cavities offer stable boundaries for measurements that are less complicated and less subject to the results of variations in the bones themselves than Huschke's or Aeby's capacities.

One of the main reasons why the cranial fossæ have not received more attention in anthropometry was undoubtedly the scarcity of suitable material, i. e., cut skulls, and it was the writer's opportunity in this particular that was the direct cause of his undertaking the measurements. From 1897 to 1903 the writer enjoyed the privilege of examining the great osteological collection in Prof. George S. Huntington's Morphological Museum in the College of Physicians and Surgeons,[g] New York, and to this were added, every year, a fair number of identified skulls, from which the calvarium had been removed for the purpose of brain demonstration. This provided an ample supply of skulls, already cut, of whites and some of negroes, to which, since 1903, it has been possible to add necessary series of Indian, fetal, and animal crania from the collections of the U. S. National Museum. The writer is particularly indebted to the Division of Mammals of the National Museum for the comparative material.

[a] Leçons d'anatomie comparée, 2 ed., Paris, 1837, p. 288.

[b] S. G. Morton, Crania Americana, Philadelphia, 1839, pp. 253–256.

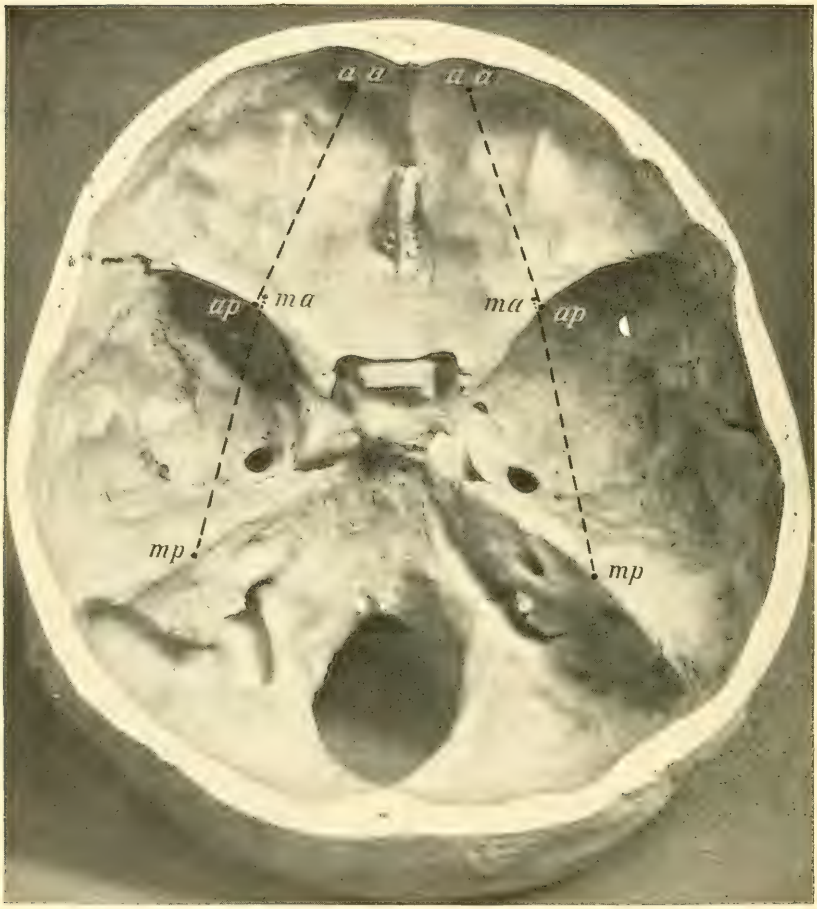
[c] E. Huschke, Schaedel, Hirn und Seele, Jena, 1854, p. 46. (Refers also to C. G. Carus, who compared the three vertebræ—frontal, parietal, and occipital—from measurements obtained between points on the exterior surface of the bones.)

[d] C. Aeby, Beiträge zur Kenntniss der Mikrocephalie, Arch. f. Anthrop., VII, 1874–1875, p. 15.

[e] V. Giuffrida-Ruggeri, La capacità della fossa cerebellare, Sperimentale, XXV 1899, pp. 131-135; also in Arch. ital. de biol., XXXII, 1899, p. 455.

[f] See especially D. J. Cunningham. Address to the Anthropological Section, British Association, Glasgow, 1901, pp. 1–13; also in the Proc. British Association of 1901.

[g] The medical department of the Columbia University.



LANDMARKS AND LINES OF MEASUREMENTS OF THE ANTERIOR AND MIDDLE FOSSAE.

aa, anterior fossa, anterior landmark; *ap*, anterior fossa, posterior landmark; *ma*, middle fossa, anterior landmark; *mp*, middle fossa, posterior landmark.

A long delay in publishing the result of this study was occasioned by lack of anthropoid ape skulls, but even this was eventually supplied from the valuable collection recently sent to the National Museum by Dr. W. L. Abbott.

The total number of specimens measured was as follows:

Skulls of adult males, white:	
Dolichocephals[a]	[b]20
Mesocephals	20
Brachycephals	20
Skulls of adult females, white:	
Dolichocephals	10
Mesocephals	10
Brachycephals	10
Skulls of adult males, Indian:	
Dolichocephals	10
Brachycephals	10
Skulls of adult males, negro,[c] dolicho- to mesocephals	15
Skulls of adult females, negro, dolicho- to mesocephals	10
Skulls of fetuses and children:	
White, brachycephals	10
Negro, brachycephals	10
Negro, dolicho- to mesocephals	20
Skulls of adult anthropoid apes	13
Skulls of adult monkeys and other mammals	10
Total crania measured	198

Considerable difficulty was encountered at the start in the choice of appropriate measurements and the fixing of good landmarks. Repeated trials showed that measurements of height and breadth of the fossæ, though highly desirable, were quite impracticable, and that to a certain extent artificial landmarks would have to be established for the longitudinal dimensions. In searching for such points from which to measure, the writer was guided by the desire of having the measurements on the bones correspond as closely as possible to definite segments or portions of the brain, and the ultimate selection in human adults was as follows:

Anterior fossæ; adults.—The anterior points from which to measure (*aa*, *aa*, Plate XIV), are located on the arc of a circle of 2 cm. radius, with the foramen cæcum as center; and 1.2 cm. laterad of the median line. They correspond closely to the lower limits of the frontal poles.

The posterior points (*ap*, *ap*) are on the free border of the lesser

[a] Dolichocephals: Cephalic index up to 75; mesocephals, 75.1 to 80; brachycephals, above 80.

[b] Some of the crania were partly damaged, so that not all the fossæ could be examined; details will be clearly seen in the final tables.

[c] Including several African blacks; among the American negroes, though all possessed the features of the race, several were probably of mixed blood (white and black).

wing of the sphenoid, 2 cm. laterad from the outer border of each optic foramen (base of the anterior clinoid process).

The line between *aa* and *ap* runs near to the line of the internal orbital sulcus of the brain and follows closely the horizontal plane of the base of the frontal lobe.

Middle fossæ; adults.—The anterior landmarks from which to measure (*ma*, *ma*,) are located at the anterior extremity of a line passing vertically beneath the points *ap*, *ap*. They correspond closely to the point of the maximum forward bulge in the line of the middle fossæ, i. e. to the poles of the temporal lobes of the cerebrum.

The posterior point (*mp*, *mp*) is on the middle of the superior border of the petrous part of each temporal bone (in the middle between the distal end of that border at the temporo-parietal suture and the medial extremity of the petrous wedge). The lines *ma–mp* are suitable representatives of the antero-posterior diameter of the temporal lobes of the brain.

The *posterior fossæ* consist each of a cerebral and a cerebellar portion, both of which were measured. For anterior landmarks of both portions in adults were chosen the points *mp*. For the posterior landmarks of the cerebellar parts of the cavity (*pi*, *pi*, Plate XV) points were selected on the lower ridge of each lateral sinus, 1.5 cm. from the median line, and the posterior points for the measurement of the cerebral part (*ps*, *ps*) are 2.5 cm. vertically above a horizontal line passing through the more superior of the *pi* marks.

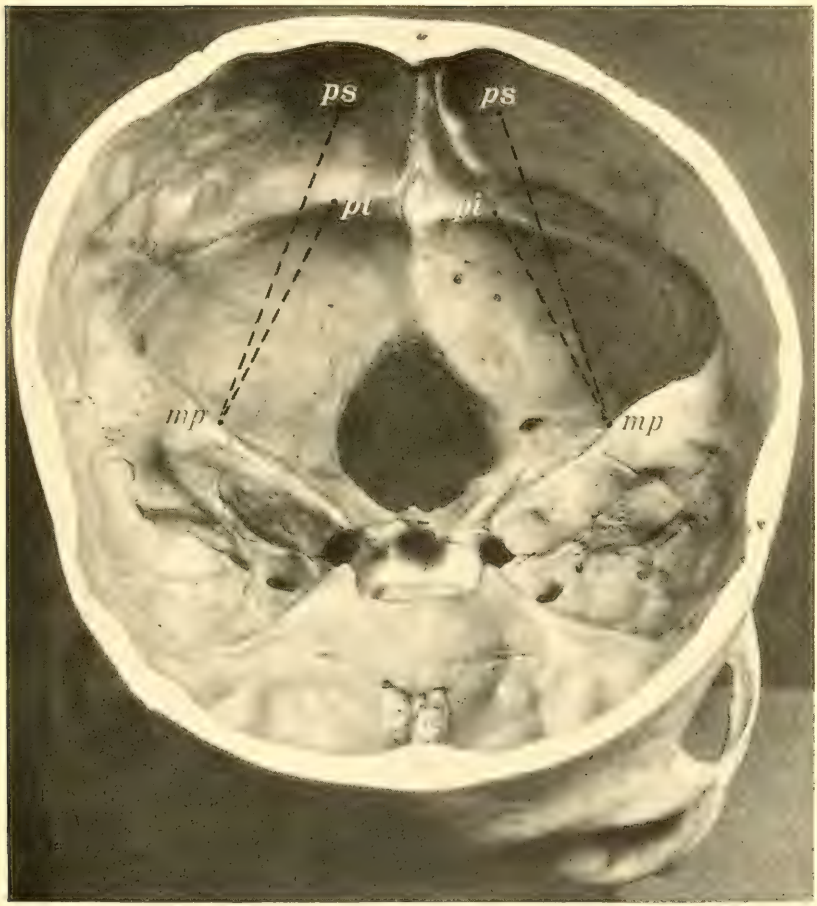
The left inferior ridge of the lateral sinus and hence the left *pi* point is in adult man very often lower than the right. In all such cases it is sufficient for practical purposes to determine the location of the right *ps* point and place the left *ps* horizontally opposite, 1.5 cm. from the median line. The median line is determined by extending the long axis of the foramen magnum.

The *mp–pi* line corresponds to the length of the superior plane of the cerebellum; while the *mp–ps* line measures the length of that part of the cerebrum which lies on the tentorium. The *ps* points correspond quite closely to the occipital poles of the cerebrum.

In the skulls of the human young and of various mammals, the landmarks were virtually the same as in human adults, with the distances between *aa* and *aa* and the points in the posterior fossæ in the smaller skulls diminished proportionately according to the size of the skull.

Several additional measurements besides the foregoing were taken on the ventral parts of the skulls and will be referred to later.

No deformed, pathological, or in any way abnormal skull was included in the series measured, and due care was exercised concerning fortuitous variations affecting the landmarks.



LANDMARKS AND LINES OF MEASUREMENTS OF THE CEREBRAL AND CEREBELLAR PARTS OF THE POSTERIOR FOSSA.

mp, middle fossa, posterior landmark; *ps*, posterior point from which to measure the cerebral part of the posterior fossa; *pi*, posterior point from which to measure the cerebellar part of the posterior fossa.

The instruments used were a small, straight, rigid, sharp-pointed compass; the ordinary anthropometric sliding compass; a compass with sharp-pointed, curved branches, each provided at its middle with an additional joint—an instrument that could be easily converted into an endocompass; and a piece of brass wire 16 cm. long and 2 mm. in diameter, bent in the middle at right angles. This wire served for measuring the middle fossa, the length being marked on it, and read off with the help of the graduated rod of the sliding compass.

To facilitate the presentation of the facts obtained, the measurements of the cerebral fossæ are not only given in absolute figures, but also in their relation to the greatest external and the mean internal antero-posterior diameters of the skull, and to the sum of the lengths of the three cavities. This latter relation, or index, equals with each fossa the length of the fossa multiplied by 100 and the result divided by the sum of the lengths of the 3 cerebral fossæ on same side of the skull.

As to the results of the measurements, it should be constantly borne in mind that they reflect only on the length of the various parts of the brain, and not on other dimensions or mass of these parts, which may be expected to show many additional and perhaps varied features. These can be determined only by extensive measurements on the brain itself.

ANTERIOR FOSSÆ.

The figures that follow give averages of the absolute lengths of the anterior cranial fossæ in the several series of human adults. These data have only a limited value in crude form, except for showing important differences on the two sides of the skull. In this respect it is seen that the average length of the right frontal cavity is greater in every series without exception. This interesting fact, not brought out before, calls for further detailed observations on the brain in this region.

Anterior fossæ: Average length in adults.

Race.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Whites	(14) 53.1	52.3 a(−0.8)	(11) 52.2	50.9 a(−1.3)	(11) 50.2	49.4 a(−0.8)	(5) 48.7	47.8 a(−0.9)	(6) 50.5	49.4 a(−1.1)	(6) 48.9	48.3 a(−0.6)
Indians	(10) 46.9	46.4 a(−0.5)	.....	.....	(10) 45.7	45.2 a(−0.5)	.....	.....	.....	.....	.....	.....
Negroes	(14) 51.2	50.0 a(−1.2)	.....	.....	.....	.....	(5) 51.1	49.2 a(−1.9)	.....	.....	.....	.....

a Difference from the right fossa.

There are individual cases in which the fossæ are of equal length or where the left fossa is the longer, but they are small in number in adult skulls and may almost be regarded as exceptions. They occurred as follows:

Length of anterior fossa on the two sides in human adults.

Skulls.	Right anterior fossa longer (per cent of cases).	Anterior fossæ of equal length (per cent of cases).	Left anterior fossa longer (per cent of cases).
14. Adults, whites, males, dolichocephals	64	14	21
12. Adults, whites, males, mesocephals	67	17	17
11. Adults, whites, males, brachycephals	64	18	18
5. Adults, whites, females, dolichocephals	80	20	0
6. Adults, whites, females, mesocephals	83	17	0
6. Adults, whites, females, brachycephals	33	50	16
10. Adults, Indians, males, dolichocephals	60	10	30
10. Adults, Indians, males, brachycephals	60	20	20
14. Adults, negroes, males, dolichocephals	57	29	14
5. Adults, negroes, females, dolichocephals	80	20	0
Totals (93 skulls)	63.5	20.5	16.0

The right anterior fossa, it is seen, exceeds in length the left in 63.5 per cent, or very nearly two-thirds, of adult human skulls, the left exceeding the right in only 16.0 per cent, or approximately one-sixth, of instances.

In the crania of small children and human fetuses, and in those of anthropoid apes and other mammals, the conditions differ from those in human adults, namely:

Length of anterior fossa on the two sides in human fetuses, etc.

Skulls.	Right anterior fossa longer (per cent of cases).	Anterior fossæ of equal length (per cent of cases).	Left anterior fossa longer (per cent of cases).
10 fetuses and children, whites, brachycephals	40	60	0
10 fetuses and children, colored, brachycephals	50	50	0
20 fetuses and children, colored, dolicho and meso cephals	50	45	5
Total (40 skulls)	47.5	50	2.5
2 chimpanzees	100	0	0
1 gorilla	(100)	0	0
6 orangs	50	33	17
4 gibbons	25	25	50
Total (13 skulls)	54	23	23
4 monkeys	25	75	0
1 lemur, 1 bear, 1 deer	[a]33	67	0

[a] The deer.

In human fetuses and children the percentage of cases where the right anterior fossa is longer than the left is decidedly smaller than in human adults, and the same is true of the cases of excess of the left fossa, while the proportion of instances where the two cavities are of the same length is much larger. This shows that although the inequality of the fossæ develops in some cases early, in utero, it does

not develop in quite a large percentage of cases until in later, postnatal life, very likely during the years of the most rapid growth of the brain and the skull. However, even in view of these cases of later development, it is impossible to regard the unevenness of the anterior fossæ, with a pronounced tendency to a moderate excess on the right side, otherwise than as a principal hereditary character.

As further data show, the predominance in length of the right frontal fossa is already well marked in those anthropoid apes that stand nearest to man; and it also occurs occasionally in monkeys and other mammals. It is therefore a rather widely shared and ancient feature.

The actual differences in length of the cavities, while often small, are in some cases very decided as shown in the following table. It may be stated here that none of the small inequalities were included in the lists unless clearly established by the sharp-pointed, straight-branched compass, measurements with which are free from error.

Absolute differences in length of the anterior fossæ; right fossa the longer in cases:

Subjects.	0.5 mm.	1 mm.	1.5 mm.	2 mm.	2.5 mm.	3 mm.	3.5 mm.	4.0 mm.	Above 4 mm.
Human adults	9	14	15	6	1	5	5	1	a3
Human fetuses and young children	6	9	0	4	0	0	0	0	0
Apes	2	2	2	1	0	0	0	0	0
Monkeys and other mammals	1	1	0	0	0	0	0	0	0

Absolute differences in length of the anterior fossæ; left fossa the longer in cases:

Subjects.	0.5 mm.	1 mm.	1.5 mm.	2 mm.	2.5 mm.	3 mm.	3.5 mm.	Above 3.5 mm.
Human adults	3	5	3	1	1	2	1	0
Human fetuses and young children	0	0	1	0	0	0	0	0
Apes	3	0	0	0	0	0	0	0

a1=4.5 mm.; 1=5.5 mm.; 1=7.5 mm.

The inequalities are greater in favor of the right fossa; they are of a smaller and restricted range in the young; they show a fair latitude in the anthropoid apes, but are very small in the lower mammals examined.

Form of skull and race, it was found, are apparently not factors in the development of the differences in length of the two cavities, and the same is probably true of sex. A reference to the detailed tables will also show that among human and anthropoid ape adults there is no regular correspondence between the variation in the relation to each other of the two frontal fossæ and the dimensions of the cranium.

The next point of importance to be cleared is the relation of the mean absolute length of the anterior fossæ to the size of the skull. Are they not only absolutely but also relatively larger in skulls of great size, and the opposite—or is the difference confined only to their abso-

lute proportions? In this instance the fossæ can be advantageously contrasted with the greatest antero-posterior (glabello-occipital) cranial diameter, one of the most familiar of skull measurements.

There are in all 60 skulls (3 series each of 20 specimens) of white males and 30 (3 series each of 10 specimens) of white females. Taking the 9 largest[a] and the 9 smallest (3 of each from each series) of the former and the 6 largest and 6 smallest (2 of each from each series) of the latter group, we find the following conditions as regards the length of the frontal cavities:

Relation of the length of the anterior fossæ to the greatest external length of the skull, in crania of extreme sizes, in whites.

	Males.	Females.
Average relation of the mean length of the two anterior fossæ to the greatest external cranial diameter, the latter being taken as 100, in the largest skulls	26.5	26.7
Extremes	24.5–28.4	25.6–28.6
The same in the smallest skulls	27.1	28.7
Extremes	25.3–28.9	25.8–30.6

The differences are not large, and the detail data showed individual exceptions to be quite numerous; nevertheless both the average values and the extremes plainly indicate a predominance of relatively longer frontal fossæ in the smallest and of relatively shorter frontal cavities in the largest crania.

Very much the same conditions as in whites were found in this regard also among the Indians and the negroes, namely:

Relation of the length of the anterior fossæ to the greatest external length of the skull in crania of extreme sizes in the Indians and negroes.

	Males.	Females.
Average relation of the mean length of the two anterior fossæ to the greatest external cranial diameter in the largest skulls:		
6 Indians (3 of each series)	26.3	.....
3 negroes	26.8	.....
2 negroes	.....	28.2
The same in the smallest skulls:		
6 Indians (3 of each series)	26.5	.....
3 negroes	28.3	.....
2 negroes	.....	28.6

The preceding figures are open to one objection—the external length of the skull, to which lengths of the fossæ were compared, includes two walls of bony tissue, and it is not certain that the proportion of the measurement due to this tissue, known to differ in the sexes and races, is the same with the large as well as the small skulls. The larger this proportion of bony substance the smaller must be the relative length of the fossæ, and the opposite. It was actually found, by comparing the dorsal with the ventral length, that in most of the series the amount of bone entering into the composition of the greatest external antero-posterior diameter of the skull is larger in

[a] The size of the skull being determined by the mean of its greatest length and breadth; height was not obtainable in most cases, but there were no extremes.

the spacious than in the small crania. The comparison of the two diameters, the mean ventral length being taken as 100, was as follows:

Relation between the greater dorsal and mean ventral length of the skull.

Skulls.	No. of specimens.	In the largest skulls.	No. of specimens.	In the smallest skulls.
White males	6	108.5 : 100	6	108.5 : 100
White females	6	109.9 : 100	6	108.5 : 100
Indian males	6	109.2 : 100	6	108.2 : 100
Negroes, both sexes	5	110.6 : 100	5	108.8 : 100

These differences make it necessary to contrast the length of the fossæ in skulls of extreme sizes with the ventral rather than dorsal length of the skull, by doing which the following proportions are obtained (the mean ventral maximum antero-posterior diameter being taken as 100):

Mean length of the anterior fossæ compared with mean ventral length of skull in the largest and smallest adult crania.

Skulls.	Number of specimens.	In the largest skulls.	Number of specimens.	In the smallest skulls.
White males	6 (2 of each series)	28.4	6 (2 of each series)	29.9
White females	do	29.7	do	30.9
Indian males	do	28.8	6 (3 of each series)	28.65
Negroes, both sexes	5 (3 males, 2 females)	30.3	5 (3 males, 2 females)	31.0

The differences are somewhat smaller than when the fossæ were compared with the external cranial length, in all except the white males; but in all of the groups, with the exception of the Indian males, the average of the relative proportions of the frontal cavities in the smallest skulls remains perceptibly above that in the largest specimens. The conclusion before reached of a predominance of relatively longer anterior fossæ in the smallest than in the largest crania is hereby confirmed.

The same interesting fact can also be brought out by contrasting the size of the skull with a number of the largest and smallest relative values of the anterior cavities. This procedure[a] gives the following results in the different groups of adult crania:

9 skulls of white males with the highest relative length[b] of the anterior fossæ.. 16.5
9 skulls of white males with the lowest relative length of the anterior fossæ ... 16.9
6 skulls of white females with the highest relative length of the anterior fossæ. 15.4
6 skulls of white females with the lowest relative length of the anterior fossæ.. 15.8
4 skulls of Indian males with the highest relative length of the anterior fossæ.. 15.5
4 skulls of Indian males with the lowest relative length of the anterior fossæ... 15.9
5 skulls of negroes with the highest relative length of the anterior fossæ..... 15.8
5 skulls of negroes with the lowest relative length of the anterior fossæ 16.1

[a] Represented by the mean of the greatest external length and breadth of the skulls.

[b] That is, the highest relation of the mean length of the two fossæ to the maximum antero-posterior (glabello-occipital) diameter of the skull.

It is seen that throughout, in adults, the relatively longer anterior fossæ correspond to smaller skulls, and the opposite. The Indian and negro, and the sex, are no exception; apparently the phenomenon is general in the whole human family. Individual cases not agreeing with the rule were met with in all the groups, but were not very numerous. The immediate cause of the condition, upon which more light will be thrown in later paragraphs, can only be a slightly less capacity, or rather necessity, of growth in length of the frontal fossæ than that of growth in length of the rest of the cranium. This can in all probability be applied also to the growth of the frontal lobes of the cerebrum, an indication of a relatively greater expansion of the other portions of the organ, containing the motor and sensory areas, in the course of development.

It remains to consider the proportions of the anterior fossæ in adults and young, men and animals, sexes, races, and different cranial forms. For these purposes the mean length of the two fossæ may be compared again with the greatest external cranial diameter. The following table presents in a succinct form the results. Only those skulls are here included in which both fossæ could be measured, which removes some possible causes of error.

Length proportions of anterior fossæ in relation to greatest external length of the skull.

Subjects.	Number of skulls.	Average external maximum length of skull.	Average mean length of the 2 anterior fossæ.	Average relation of the length of the fossæ to the dorsal length of the skull, and extremes.
Adults:				
Whites, males—		*cm.*	*mm.*	
Dolichocephals	14	19.4	52.7	27.2 (25.3–28.8)
Mesocephals	11	18.7	51.5	27.5 (24.3–30.2)
Brachycephals	11	18.2	49.8	27.3 (24.5–30.9)
Whites, females—				
Dolichocephals	5	17.8	48.2	27.1 (24.6–30.6)
Mesocephals	6	17.8	49.7	28.1 (26.1–30–6)
Brachycephals	6	17.3	48.6	28.2 (25.6–31.2)
Indians, males—				
Dolichocephals	10	18.3	46.6	25.5 (22.7–29.6)
Brachycephals	10	16.9	45.4	26.8 (24.4–28.5)
Negroes—				
Males, dolicho- and mesocephals	14	18.6	50.6	27.3 (25.3–30.7)
Females, dolicho-and mesocephals	5	17.7	50.1	28.3 (26.2–30.2)
Fetuses and young:				
White fetuses and children, brachycephals	10	.....	.....	31.1 (28.6–35.0)
Colored fetuses and children:				
Brachycephals	10	.....	.....	30.9 (27.5–35.7)
Dolicho-and mesocephals	20	.....	.....	30.6 (26.1–35.6)
Anthropoid apes:				
Chimpanzees	2	11.9	39.0	32.9 (31.4–34.0)
Orangs	6	11.0	36.2	30.4 (28.2–32.8)
Gibbons	4	7.5	27.3	36.2 (35.0–37.3)
Monkeys and lemurs:				
Macacus pelops	1	8.2	29.5	36.0
Cebus hypoleucus	1	7.5	23.2	30.0
Alouata senicula	1	7.0	23.0	32.9
Midas	1	4.1	13.0	31.7
Lemur varius	1	6.0	22.0	36.7

The above data certainly reveal interesting conditions.

The relative length of the anterior fossæ is in general decidedly greater in fetuses and young than in adults; the antero-posterior

development of the frontal cavities, therefore, lags behind the development of the rest of the skull in the same direction throughout growth. This harmonizes well with the relatively small frontal fossæ in many of the largest adult crania. A remarkable diminution in the relative length of the anterior fossæ takes place during fetal growth itself. Thus, in the six smallest fetuses and the six largest children,[a] the mean lengths of the fossæ were toward the greatest external length of the skull, respectively as 32.9 (28.6–35.0) and 30.1 (28.0–33.1) to 100. Individual variation is quite pronounced at all stages of life.

The differences, in man and lower mammals, between the length of the anterior fossæ as related to the greatest external length of the skull are much like those between human adults and young. In all the species of animals examined, the anthropoid apes included, the relative length of the frontal cavities is greater than that in human adults; in a few instances it is even greater than in the human young. If the anterior lobes of the brain correspond in dimensions to the anterior fossæ, as we believe, the facts shown by the figures relating to the young, and especially to the other mammals than man, mean a striking change in our notions concerning the relative size of those parts of the cerebrum in the beings involved. There are differences between the various species of anthropoid apes and monkeys, but from the small number of specimens it is impossible to conclude how far these differences are characteristic of definite groups.

As to sexes, the females, both among the whites and negroes, show on the whole, relatively longer anterior fossæ than the males. This difference is not large and agrees with the smaller size of the female skull. The female sex appears in this, as in so many other features, slightly nearer the infantile conditions.

The racial differences in the frontal cavities are of a peculiar nature. In whites and negroes the relative proportions of the anterior fossæ, as contrasted with the length of the skull, are practically alike, but in the Indian they are decidedly smaller. The latter condition is not due to a large development of the Indian skulls; in fact these are smaller than either those of the whites or those of the negroes of the same sex.

There are certain differences in the relative length of the anterior fossæ between dolichocephalic and brachycephalic crania, the proportion being in all the groups slightly higher in average in the latter than in the former. No clear reason for this has been arrived at. The series overlap to a considerable extent through individual irregularities.

The familiar greatest antero-posterior (glabello-occipital) diameter has proved very serviceable for contrasting the dimensions of the

[a] For sizes see detailed tables at the end of the paper. Only one of the children reached as high as about the sixth year of age. All the others were much younger.

anterior fossæ, but certain objections, valid and partly shown before, are liable to be raised against it.[a] It is therefore advisable to contrast the length of the cavities in all the series also with the mean ventral diameter of the crania.[b] The next table gives the relations of the mean of the two frontal fossæ with the mean ventral length of the skulls in all the groups dealt with in the preceding list, and it will be seen that, though the figures differ a little, the results are substantially identical.

Mean length of the anterior cranial fossæ in relation to the mean of the right and left greatest ventral diameters of the skull.

Subjects.	Number of skulls.	Average relation of the fossæ (mean ventral length =100).	Average relation of the fossæ (greatest external length=100).	Number of skulls.
Adults:				
Whites, males—				
Dolichocephals	6	29.3	27.2	14
Mesocephals	9	29.5	27.5	11
Brachycephals	8	29.6	27.3	11
Whites, females—				
Dolichocephals	5	29.4	27.1	5
Mesocephals	6	30.4	28.1	6
Brachycephals	4	30.0	28.2	6
Indians, males—				
Dolichocephals	10	28.0	25.5	10
Brachycephals	10	29.5	26.8	10
Negroes—				
Males, dolicho- and mesocephals	13	30.4	27.3	14
Females, dolicho- and mesocephals	4	31.0	28.3	5
Fetuses and young:				
White fetuses and children, brachycephals	9	33.1	31.1	10
Colored fetuses and children, brachycephals	10	32.2	30.9	10
Dolicho- and mesocephals	20	32.3	30.6	20
Anthropoid apes:				
Chimpanzees	2	35.3	32.9	2
Orangs	6	34.4	30.4	6
Gibbons	4	37.5	36.2	4
Monkeys and lemurs:				
Macacus pelops	1	38.3	36.0	1
Cebus hypoleucus	1	34.7	30.0	1
Alouata senicula	1	39.1	32.9	1
Midas	1	33.1	31.7	1
Lemur varius				
Other mammals:	1	41.5	36.7	1
Ursus americanus	1	38.4		
Deer	1	34.1		

The position of the Indian is seen in this table in a clearer light, and the same is true of the negro, the former appearing nearer to the white man and the latter nearer to less developed forms of crania. The exceptional position of the gibbons among the anthropoid apes, and of the macaque, alouata, and lemur in the following group, remains accentuated.

The correlation of the anterior with the other fossæ of the skull will be treated of later on.

[a] Varying dimensions of the glabella and occipital ridges; the point chosen in apes instead of glabella; the varying thickness of bone included.

[b] Average of the greatest internal length of the right and left side.

MIDDLE FOSSÆ.

The absolute average length of the middle fossæ in human adults shows as follows:

Middle fossæ: Average length in adults.

Race.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Whites	(14) 54.9	54.8 (*a*−0.1)	(11) 55.3	55.1 (*a*−0.2)	(11) 55.4	56.5 (*a*+1.1)	(5) 51.3	50.7 (*a*−0.6)	(6) 52.7	52.1 (*a*−0.6)	(6) 51.4	51.4 (*a*+−0)
Indians	(10) 53.3	51.8 (*a*−1.5)	.....	.....	(10) 53.6	51.9 (*a*−1.7)	.....	.....	.....	.....	.....	.....
Negroes	(14) 53.4	53.5 (*a*+0.1)	.....	.....	.....	.....	(5) 49.8	49.6 (*a*−0.2)	.....	.....	.....	.....

a Differences from the right fossa.

The cavities, it is seen, are slightly longer than the anterior ones (in the proportion of 108 to 100—a detailed comparison in a future paragraph). There is again a predominance in the length of the right fossa, but it is not as great or equally frequent as in the case of the anterior fossæ.

Length of middle fossa on the two sides in human adults.

Skulls.	Right middle fossa longer (per cent of cases).	Middle fossæ of equal length (per cent of cases).	Left middle fossa longer (per cent of cases).
16 adults, whites, males, dolichocephals	31	37	31
14 adults, whites, males, mesocephals	43	21	36
15 adults, whites, males, brachycephals	40	33	27
8 adults, whites, females, dolichocephals	50	12	37
7 adults, whites, females, mesocephals	43	29	29
6 adults, whites, females, brachycephals	33	50	17
10 adults, Indians, males, dolichocephals	70	20	10
10 adults, Indians, males, brachycephals	50	40	10
15 adults, Negroes, males, dolichocephals	47	27	27
9 adults, Negroes, females, dolichocephals	33	22	44
Total (110 skulls)	44	29	27

With the anterior fossæ the conditions were: Right longer, 63.5; equal, 20.5; and left longer, 16 per cent.

In the skulls of the fetuses and young, and in those of anthropoid apes and other mammals, the results differ from those in human adults. There were among:

Length of middle fossa on the two sides in human fetuses, etc.

Skulls.	The right middle fossa longer.	Middle fossæ equal.	The left middle fossa longer.
	Per cent.	*Per cent.*	*Per cent.*
40 human fetuses and young	35	50	15
13 anthropoid apes	69	23	8
7 other mammals	29	43	29

These figures show again, as did similar data with the anterior fossæ (q. v.), that in the fetuses and young the proportion of cases where either the right or the left cavity is longer is much smaller than in the adults, and points to the fact that irregularities are to a large extent of later development. In the anthropoid apes I find a higher differentiation in the middle fossæ than in the human young, similarly as with the anterior cavities.

The actual differences between the middle fossæ ranged thus:

Absolute differences in length of the middle fossæ; right fossa the longer in cases:

Subjects.	0.5 mm.	1 mm.	1.5 mm.	2 mm.	2.5 mm.	3 mm.	3.5 mm.	4 mm.	Above 4 mm.
Human adults	5	17	6	11	3	3	1	1	a1
Human fetuses and young	1	9	2	2	0	0	0	0	0
Anthropoid apes	3	4	0	1	1	0	0	0	0
Monkeys and other mammals	1	1	0	0	0	0	0	0	0

a 6.5 mm.

Absolute differences in length of the middle fossæ; left fossa the longer in cases:

Subjects.	0.5mm.	1 mm.	1.5mm.	2 mm.	2.5mm.	3 mm.	3.5mm.	4 mm.	Above 4 mm.
Human adults	3	11	2	5	1	3	2	2	a1
Human fetuses and young	2	4	0	0	0	0	0	0	0
Anthropoid apes	0	1	0	0	0	0	0	0	0
Monkeys and other mammals	1	1	0	0	0	0	0	0	0

a 5.5 mm.

The conditions disclosed by the above figures are such that almost the exact words which were used in describing the differences in the anterior fossæ are applicable. In this case, as there, the range of differences is somewhat greater with the right fossa; the inequalities are smaller in the young; they show a range of fair extent in the anthropoid apes, though the skulls are less than half the size of full-grown human crania, and they are very small in the monkeys and other mammals.

The form of the skull may have some slight connection in this case with the differences in the length of the cavities. In three of the series (white females, Indians, negroes) the right fossa is longer than the left in a larger percentage of the dolichocephals than of the brachycephals (in dolichocephals in 50, 70, 47 per cent; in brachycephals, respectively, in 33, 50, and 33 per cent of cases). Race may also be a factor, for a larger proportion of cases with longer right middle fossa is found among the Indians than in any of the other series. As to sex, no influence on the difference between the lengths of the two middle cavities is apparent.

A comparison of the inequalities in length in the middle with those of the anterior fossæ reveals the fact that these disproportions can be

only in a limited number of cases compensatory in nature; in a large percentage of the crania there is no trace of a correlation. The following conditions exist in this regard among the human adults:

	Per cent of cases.
Anterior fossæ of equal length, middle fossæ of equal length	4.3
Anterior fossæ of equal length, right middle fossa longer than left	10.9
Anterior fossæ of equal length, right middle fossa shorter than left	5.4
Right anterior fossa longer than left—	
middle fossæ equal	20.7
right middle fossa longer than left	29.3
right middle fossa shorter than left	13.0
Right anterior fossa shorter than left—	
middle fossæ equal	4.3
right middle fossa longer than left	8.7
right middle fossa shorter than left	3.3

The only two series of cases where a compensation between the length of the anterior and middle fossa of the same side may exisit (that is, "the right anterior fossa longer than the left—the right middle fossa shorter than the left," and the opposite) embrace only 13 and 8.7, in total 21.7 per cent, or about one-fifth of all the skulls examined. On the other hand, a greater length of both the anterior and middle fossa on the same side was present in 29.3 per cent (right side) and 3.3 per cent (left side), in all 32.6 per cent, or almost one-third, of the crania. These facts show that the dimensions of one pair of the fossæ in question are to a large extent independent of those of the other pair, which make it plain that they are not due to conditions inherent in the bones themselves, but to those pertaining to the brain.

The relations which the mean length of the two middle fossæ bear to the size of the skull are indicated in the figures below. As with the anterior cavities, the size of the skull was judged from the mean of its greatest length and breadth; the fossæ were contrasted with the greatest external as well as the mean ventral length. The specimens selected for this comparison were the same as with the frontal fossæ on a similar occasion.

Average relations of the mean length of the two middle fossæ to the greatest dorsal and mean ventral length of the skull (each of these diameters being each taken as 100), in the largest and smallest skulls of the series.

Subject.	Number of specimens.	In the largest crania—		Number of specimens.	In the smallest crania—	
		vs. external length.	*vs.* internal length.		*vs.* external length.	*vs.* internal length.
Adults:						
White males	6 (2 of each series)	28.9	31.2	6 (2 of each series)	27.5	29.9
White females	6 (2 of each series)	27.7	30.4	6 (2 of each series)	29.6	32.3
Indian males	6 (3 of each series)	26.3	28.8	6 (3 of each series)	26.5	28.6
Negroes, both sexes	5 (3 males, 2 females)	27.4	30.3	5 (3 males, 2 females)	28.5	31.0

The conditions are irregular. The length of the middle fossæ in the smallest skulls exceeds that in the largest specimens among the white males and in the negroes; in the white females the facts are the reverse; while in the Indians the differences are immaterial. Much larger numbers of cases would probably clear up the matter; as it is, it is necessary to reserve conclusions.

The differences in the absolute and relative length proportions of the middle fossæ between adults and young, in man and animals, in the sexes, in races, and various forms of the skull, are contrasted in the table that follows:

Length proportions of middle fossæ in relation to greatest external length of the skull.

Subjects.	Number of skulls.	Average dorsal maximum length of skull.	Average mean length of the two middle fossæ.	Average relation of the length of the fossæ to the dorsal length of the skull.	Average relation of the length of the fossæ to the ventral length of the skull.	Number of skulls.
Adults:						
White males—		*cm.*	*mm.*			
Dolichocephals	14	19.4	54.9	28.3	31.9	10
Mesocephals	11	18.7	55.2	29.4	32.2	14
Brachycephals	11	18.2	55.9	30.7	33.9	10
White females—						
Dolichocephals	5	17.8	51.0	28.6	31.4	10
Mesocephals	6	17.8	52.4	29.5	33.0	9
Brachycephals	6	17.3	51.4	29.8	32.0	5
Indian males—						
Dolichocephals	10	18.3	52.5	28.7	31.5	10
Brachycephals	10	16.9	52.7	31.2	34.3	10
Negroes—						
Males, dolicho- and mesocephals	14	18.6	53.5	28.8	31.9	13
Females, dolicho- and mesocephals	5	17.7	49.7	28.1	31.1	8
Fetuses and young	40	9.1	26.2	28.8	30.2	39
White, brachycephals	10	7.9	24.4	30.7	32.1	9
Colored, brachycephals	10	9.2	26.6	28.9	30.1	10
Colored, dolicho- and mesocephals	20	9.7	26.9	27.8	29.3	20
Anthropoid apes:						
Chimpanzees	2	11.9	38.5	32.3	34.8	2
Orangs	6	11.9	37.1	31.1	35.3	6
Gibbons	4	7.5	24.2	32.0	33.2	4
Monkeys and lemurs:						
Macacus pelops	1	8.2	28.5	34.7	37.0	1
Cebus hypoleucus	1	7.5	24.0	32.0	35.8	1
Alouata senicula	1	7.0	25.7	36.8	43.8	1
Midas	1	4.1	15.2	37.2	38.8	1
Lemur varius	1	6.0	22.5	37.5	42.4	1

Contrary to what was witnessed with the frontal fossæ, the middle cavities in the human young (particularly in the dolicho- and mesocephalic colored fetuses) show somewhat smaller relative proportions than in the adults. The increase in their relative value within the series, from the smallest to the largest fetuses, is very irregular.

In anthropoid apes the middle fossæ are relatively slightly longer, in the monkeys and lemurs decidedly longer, than in any of the human series. They differ most widely in this from the human young.

In sexes the relative proportions of the middle cavities differ quite immaterially. Neither are there any great racial differences, though

it should be noted that the Indian male brachycephals show the maximum and the negro dolichocephals the minimum proportions.

There are, however, even more so than with the frontal cavities (q. v.), differences of the relative length of the middle fossæ in the different forms of the skull, this length being throughout smaller in the dolichocephals than in the brachycephals, while with the mesocephals it is mostly intermediary. Even in the young the proportions are higher in the short than in the long crania. The differences regarding the frontal fossæ were, it will be remembered, of a like nature, though seemingly of different morphological significance.

The correlation of the middle with the other fossæ will be dealt with in a future section.

POSTERIOR FOSSÆ: CEREBRAL PORTION.

The absolute lengths of these fossæ are as indicated in the figures that follow. In the three upper lines of the table are represented only those skulls in which also all the other fossæ could be measured, that is, skulls which correspond to those given in tables of absolute measurements of the middle and frontal cavities; while in the fourth line are the lengths of all the pairs of the postero-superior fossæ in the skulls examined. The two lines of figures show no great difference.

Posterior fossæ, cerebral part: Average length in adults.

Race.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Whites	(14) 81.0	83.2 a(+2.2)	(11) 79.6	81.8 a(+2.2)	(11) 75.9	78.7 a(+2.8)	(5) 74.0	77.8 a(+3.8)	(6) 75.8	78.1 a(+2.3)	(6) 75.0	75.6 a(+0.6)
Indians	(10) 79.2	82.4 a(+3.2)			(10) 73.5	74.1 a(+0.6						
Negroes	(14) 77.3	80.2 a(+2.9)					(5) 74.4	76.6 a(+2.2)				
Whites, all skulls in which the two fossæ could be measured	(20) 80.5	81.7 a(+1.2)	(19) 78.3	80.4 a(+2.1)	(19) 76.3	78.8 a(+1.5)	(10) 73.8	76.8 a(+3.0)	(9) 76.0	78.7 a(+2.7)	(9) 73.6	75.7 a(+2.1)

a Difference from the right fossa.

The most striking feature of the above data is the evidence that in all the groups and series the left fossa is the longer, which is the reverse of what was observed with the middle and especially with the

anterior cavities; and the differences are in most cases very decided. Individually, the cases where the left fossa is not the longer are in nearly all the series comparatively infrequent, namely:

Length of postero-superior fossa on the two sides in human adults.

Skulls.	Right postero-superior fossa longer (per cent of cases).	Fossæ equal (per cent of cases).	Left postero-superior fossa longer (per cent of cases).
Adults:			
Whites, males—			
Dolichocephals	20	15	65
Mesocephals	21	11	68
Brachycephals	0	11	89
Whites, females—			
Dolichocephals	20	0	80
Mesocephals	11	11	78
Brachycephals	25	12	63
Indians, males—			
Dolichocephals	20	0	80
Brachycephals	50	0	50
Negroes—			
Males, dolichocephals	20	0	80
Females, dolicho- and mesocephals	40	0	60

The left fossa is shown to be the longer in from 50 to 90 per cent of the cases in the various series, or in over 72 per cent, or nearly three-fourths of the crania, if we take all the 130 skulls together. The middle fossæ, it was seen, showed in 44 per cent, and the anterior cavities in 63.5 per cent, an excess in the length on the right side.

Among the human young and the anthropoid apes, and in other mammals, the conditions were as follows:

Length of postero-superior fossa on the two sides in human fetuses, etc.

Skulls.	Right postero-superior fossa longer.	Fossæ equal.	Left postero-superior fossa longer.
	Per cent.	*Per cent.*	*Per cent.*
40 human fetuses and young	17	45	37
13 anthropoid apes	15	23	62
7 monkeys and other mammals	43	14	43

In the human young there is a much larger percentage than in adults of postero-superior fossæ of equal length, showing again, as with the middle and anterior cavities, that the inequalities are often of later development. In the present case this seems to be true particularly of the excess of length on the left side. In the anthropoid apes the conditions are not much different from those in human adults, which indicates that the predominance of excess of length in the left postero-superior fossa, and of that portion of the cerebrum which enters into it, is an ancient feature which has not been acquired and has scarcely been modified in man. Among monkeys and lower mammals there seems to be less regularity in the unevenness of the postero-superior

cavities, but the number of cases is not sufficient for any definite conclusion.

The absolute difference in the length of the two postero-superior fossæ is often very pronounced, much more so than in the case of the frontal and middle cavities. It ranged as follows:

Absolute differences in length of the postero-superior fossæ; right fossa the longer in cases:

Subjects.	0.5 mm.	1.0 mm.	1.5 mm.	2.0 mm.	2.5 mm.	3.0 mm.	3.5 mm.	4.0 mm.	4.5 mm.	5.0 mm.	5.5 mm.	6.0 mm.	6.5 mm.	7.0 mm.	Over7 mm.
Human adults	5	6	4	4	0	3	1	1	0	2	6	1	0	0	*a* 2
Human fetuses and young	1	5	0	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Anthropoid apes	0	1	0	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Monkeys and other mammals	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Adsolute differences in length of the postero-superior fossæ; right fossa the longer in cases:

Subjects.	0.5 mm	1.0 mm.	1.5 mm.	2.0 mm.	2.5 mm.	3.0 mm.	3.5 mm.	4.0 mm.	4.5 mm.	5.0 mm.	5.5 mm.	6.0 mm.	6.5 mm.	7.0 mm.	Over7 mm.
Human adults	0	14	7	7	12	5	6	12	3	4	10	5	3	2	*b* 2
Human fetuses and young	2	5	1	5	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Anthropoid apes	0	1	2	1	1	2	1	.....	.....	.....	.....	.....	.....	.....	.....
Monkeys and other mammals	0	1	0	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

a 8 mm. *b* 1 of 8.5 mm.; 1 of 11 mm.

In 25 subjects, it is seen, the inequality in the length of the two fossæ exceeded half a centimeter, and in one it reached 11 millimeters.

Those figures of the preceding table that concern human adults can be more conveniently expressed in percentages, thus:

Posterior superior fossæ longer by—

0.5 to 2.0 mm., right in 65.5 per cent, left in 30.4 per cent of cases.
2.5 to 4.0 mm., right in 17.2 per cent, left in 38.0 per cent of cases.
4.5 to 6.0 mm., right in 10.3 per cent, left in 24.0 per cent of cases.
Above 6.0 mm., right in 6.9 per cent, left in 7.6 per cent of cases.

The above brings out clearly a predominance of the minor differences in that category of cases where the right fossa is longer, and of the greater inequalities in the larger class of cases where the left fossa exceeds in length. Similar conditions were noticed with the middle and the anterior cavities; on the side (in both these instances the right) where there was a prevalence of longer fossæ, there were also noticed greater actual differences in length from the opposite cavity, and the reverse.

The influences on the length of the two postero-superior fossæ of skull-form, sex, and race are not clearly defined; the question might possibly be settled by much larger series of skulls.

A comparison of the length of the postero-superior fossæ with the combined length of the middle and anterior cavities shows that frequently the greater length of one of the former stands in what is in

all probability compensatory relation with the latter. The following conditions existed in this regard among the human adults.

	Per cent of cases.
Anterior (*a*)+middle (*m*) fossæ of equal length, postero-superior (*ps*) fossæ of equal length	0
a+*m* of equal length, right *ps* longer than left	1.1
a+*m* of equal length, right *ps* shorter than left	7.6
Right *a*+*m* longer than left, *ps* equal	2.2
Right *a*+*m* longer than left, right *ps* longer than left	12.0
Right *a*+*m* longer than left, right *ps* shorter than left	56.5
Right *a*+*m* shorter than left, *ps* equal	4.3
Right *a*+*m* shorter than left, right *ps* longer than left	6.5
Right *a*+*m* shorter than left, right *ps* shorter than left	9.8

In 63 (56 + 6.5) per cent of the cases the length of the postero-superior fossa stood in an apparently compensatory relation to the joint length of the two other cavities of the same side. A certain proportion of this number of cases, very probably the majority, represents a true compensation, the rest being due to conditions inherent in the posterior fossæ themselves or, more properly, in peculiarities of those portions of the cerebrum which fill them. In 21.8 (right 12, left 9.8) per cent of the skulls the postero-superior fossa on one side was longer, notwithstanding the fact that the sum of the length of the middle and anterior cavities on the same side was also longer than that on the opposite side. In several of these cases all the three cavities on the same side were individually longer than those on the other side of the same skull. In no case among the 92 adult human crania were all the three fossæ of one side exactly equal to those opposite. The tendency to a greater length of the left postero-superior fossa is very pronounced. It accompanies, in the skull, and is the main manifestation of, the prevalent greater length of the left cerebral hemisphere.

The relations born by the mean length of the postero-superior fossæ to the size of the skull, the latter judged as before, from the mean of its greatest length and breadth, are indicated beneath, the specimens represented being the same as with the frontal and middle fossæ on the occasion of similar comparison.

Average relation of the mean length of the two postero-superior fossæ to the greatest dorsal and mean ventral length of the skull (each of these diameters being taken as 100) in the largest and smallest skulls of the series.

Skulls.	In the largest crania.			In the smallest crania.		
	No. of specimens.	*vs.* external length.	*vs.* internal length.	No. of specimens.	*vs.* external length.	*vs.* internal length.
Adults:						
White males	6	43.2	46.9	6	43.1	46.8
White females	6	42.9	47.2	6	43.0	46.7
Indian males	6	43.8	47.9	6	43.7	47.3
Negroes, both sexes	5	41.7	46.2	5	44.0	47.9

No regular or substantial difference is apparent. There is no compensation in this regard between the postero-superior and the anterior cavities, which latter, it will be remembered, are relatively shorter in the largest than in the smallest crania.

The absolute and relative length proportions of the postero-superior fossæ, contrasted between adults and young, man and animals, sexes, races, and in the main cranial forms, are presented in the following table:

Length proportions of postero-superior fossæ in relation to greatest external length of the skull.

Subjects.	Number of skulls.	Average external maximum length of skull.	Average mean length of the two postero-superior fossæ.	Average relation of the length of the fossæ to the dorsal length of the skull.	Average relation of the length of the fossæ to the ventral length of the skull.	Number of skulls.
Adults:						
Whites, males—		*cm.*	*mm.*			
Dolichocephals	14	19.4	82.1	42.4	45.9	10
Mesocephals	11	18.7	80.7	43.0	46.0	14
Brachycephals	11	18.2	77.3	42.4	46.4	10
Whites, females—						
Dolichocephals	5	17.8	75.9	42.6	45.8	10
Mesocephals	6	17.8	76.9	43.3	46.8	9
Brachycephals	6	17.3	75.3	43.5	47.4	5
Indians, males—						
Dolichocephals	10	18.3	80.8	44.2	48.5	10
Brachycephals	10	16.9	73.8	43.6	48.0	10
Negroes—						
Males, dolicho- and mesocephals	14	18.6	78.7	42.4	46.7	13
Females, dolicho- and mesocephals	5	17.7	75.5	42.7	46.9	8
Human fetuses and young	40	9.1	41.1	44.5	46.9	39
Anthropoid apes:						
Chimpanzees	2	11.9	49.8	41.7	45.0	2
Orangs	6	11.9	51.0	42.8	48.5	6
Gibbons	4	7.5	30.8	40.7	42.3	4
Monkeys and lemurs:						
Macacus pelops	1	8.2	32.5	39.6	42.2	1
Cebus hypoleucus	1	7.5	28.0	37.3	41.8	1
Alouata senicula	1	7.0	24.5	35.0	41.7	1
Midas	1	4.1	16.5	40.2	42.0	1
Lemur varius	1	6.0	17.3	28.7	32.5	1

The average relative proportions of the postero-superior cavities differ, it is seen, but little between human adults and the young; taken as a whole, the middle fossæ presented a moderate, the frontal cavities a marked, diversity at the two periods of life. If we compare the relative proportions of the postero-superior fossæ in the smallest fetuses of the series, namely, in those where the vertex-breech length was less than 20 cm. with those where it was above that, we find somewhat different conditions, as shown in the following table:

Case.	Vertex-breech length in centimeters.	Relation of the mean length of the postero-superior fossæ to the—	
		dorsal length of the skull.	mean ventral length of the skull.
1	5.2	33.3	42.4
2	8.3	41.7	47.2
3	15.9	37.6	40.4
4	17.4	40.6	44.8
5	17.6	37.6	40.9
6	19.9	44.7	45.4

The relation to the dorsal length of the skull is in these cases probably the more reliable, as the ventral length can easily and imperceptibly be augmented a little by the relaxation of the bones consequent upon the removal of the parietals, which constituted the method of opening the small skulls. However, compared to either the external or internal cranial length, the fossæ are in the majority of the cases shown to be smaller than during later development. In fetuses in which the vertex-breech length is above 20 cm. the relative dimensions of the fossæ are much more like those in adults, showing that the attainment of their full relative length takes place very early.

In anthropoid apes, monkeys, and lemur, with the sole exception of the orang, the postero-superior cavities are relatively shorter than in human adults, agreeing in this respect with what exists in the earlier stages of fetal life in man. The proportions are particularly low in the lemur.

No definite difference in the relative length of the postero-superior cavities appears in the sexes. Among races, they are longest in the Indian, the whites and negroes being near alike. As to the main cranial forms, among whites the fossæ are in both sexes in the average slightly longer in the meso- than in the dolichocephals, and still longer in the brachycephals, while among the Indians and the young it is the fossæ in the dolichocephals that are slightly longer. The differences in this respect are, however, throughout too small to be of much significance; besides, individual exceptions are numerous in all the series.

THE THREE CEREBRAL FOSSÆ CONSIDERED TOGETHER.

The sum of the lengths of the three cerebral fossæ on each side shows this interesting distribution:

Sum of lengths of cerebral fossæ.

Subjects.	No. of cases.	*a+m+ps.*	
		Right side.	Left side.
		cm.	*cm.*
Whites, males:			
Dolichocephals	14	18.9	19.0
Mesocephals	11	18.7	18.8
Brachycephals	11	18.1	18.4
Whites, females:			
Dolichocephals	5	17.4	17.6
Mesocephals	6	17.9	18.0
Brachycephals	6	17.5	17.5
Indians, males:			
Dolichocephals	10	17.9	18.1
Brachycephals	10	17.3	17.1
Negroes, males:			
Dolicho- and mesocephals	14	18.2	18.4
Negroes, females:			
Dolicho- and mesocephals	5	17.5	17.5
Human fetuses and young	40	9.55	9.5
Anthropoid apes	13	11.3	11.3
Monkeys and lemur	5	6.9	6.9

[*a*, anterior; *m*, middle; *ps*, postero-superior fossa.]

In seven of the ten series of human adults the average of the sum of the lengths of the three cerebral fossæ on the left exceeds that of the right side by from 1 to 3 millimeters. There is therefore a clear, though small, excess of fossal length on the left in the mass of human adult crania. In two series the averages are equal; while in one series, the brachycephalic Indians, an excess (2 mm.) is shown for the right side. In the human young, anthropoid apes, and monkeys, the difference in the averages are nil, or not exceeding half a millimeter.

Individually the sum of the lengths of the three fossæ on each side was as follows:

Combined length of cerebral fossæ on the two sides.

Subjects.	Right $a+m+ps$ longer than left in—	Equal in—	Left $a+m+ps$ longer than right in—
	Per cent.	*Per cent.*	*Per cent.*
Whites, males:			
Dolichocephals	14	21	64
Mesocephals	36	0	64
Brachycephals	45	0	55
Whites, females:			
Dolichocephals	0	20	80
Mesocephals	33	0	66
Brachycephals	50	17	33
Indians, males:			
Dolichocephals	30	0	70
Brachycephals	60	20	20
Negroes, males:			
Dolicho- to mesocephals	21	14	64
Negroes, females:			
Dolicho- to mesocephals	40	0	60
Human fetuses and young	50	25	25
Anthropoid apes	46	23	31
Monkeys and lemur	50	17	33

[a, anterior; m, middle; ps, postero-superior fossa.]

These figures reveal several facts of some importance. Among the human adults the brachycephals show all through a remarkably greater proportion of larger fossal length on the right and smaller on the left side than the mesocephals, and especially the dolichocephals. And similarly large percentage of longer right fossal length exists in the human young, the anthropoid apes, and the monkeys and lemur. Sex shows no particular difference, and the influence of race is small, if any. The brachycephals stand in this feature decidedly nearer the human young and the other primates than man, than the dolichocephals. It is, of course, possible that the prevalence of a greater fossal length on the right side is due to different causes in these several groups, but more likely there is some relation in these phenomena.

The actual differences in the combined fossal length ranged thus:

Anterior, middle, and postero-superior fossæ longer than the same of the opposite side.

Subjects.	0.5 mm.	0.1 mm.	1.5 mm.	2.0 mm.	2.5 mm.	3.0 mm.	3.5 mm.	4.0. mm.	4.5. mm.	5.0. mm.	5.5. mm.	6.0. mm.	Above 6.0. mm.
Human adults:													
Right longer.....cases..	8	5	1	0	2	0	1	4	2	2	1	1	[a]2
Left longer .....do....	6	6	4	8	2	6	1	5	1	5	2	0	[b]3
Human young:													
Right longer .....do....	4	7	2	5	2	0	0	0	0	0	0	0	0
Left longer .....do....	3	3	1	1	1	1	0	0	0	0	0	0	0
Anthropoid apes:													
Right longer .....do....	1	4	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Left longer .....do....	1	1	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Monkeys and lemur:													
Right longer .....do....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Left longer .....do....	0	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[a] 1 = 6.5 mm.; 1 = 7 mm. [b] 1 = 6.5 mm.; 1 = 8 mm.; 1 = 12 mm.

The greatest of the differences among the human adults are on the left side; also the proportion of cases with large differences is greater where the left combined fossal length is greater. In the human young the differences are smaller, showing that the peculiarity is to quite a large degree of later development, which agrees with what was observed with all the individual cavities. In anthropoid apes and monkeys the differences are relatively small, exceeding in no case 2 millimeters.

It remains to show how the combined fossal length agrees with the greatest ventral length of the skull of the same side. The succeeding table gives the averages of the right and left ventral antero-posterior diameters in human adults. It will be seen that here also, as with the $a + m + ps$ length the left diameter preponderates in the mass of the specimens, and it will also be noticed that in the white brachycephals there is scarcely any difference, while in the white dolichocephals, both male and female, the inequality is pronounced.

Ventral antero-posterior maximum diameter of the skull.

Subjects.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Whites	(8) 17.5	(8) 17.7 [a](+0.2)	(12) 17.23	(12) 17.27 [a](+0.04)	(9) 16.7	(9) 16.7 [a](+−0)	(7) 16.3	(7) 16.6 [a](+0.3)	(6) 16.4	(6) 16.5 [a](+0.1)	(4) 15.9	(4) 15.95 [a](+0.5)
Indians	(10) 16.6	(10) 16.7 [a](+0.1)	.....	.....	(10) 15.3	(10) 15.4 [a](+0.1)	.....	.....	.....	.....	.....	.....
Negroes	(13) 16.7	(13) 16.8 [a](+0.1)	.....	.....	.....	.....	(7) 16.2	(7) 16.1 [a](−0.1)	.....	.....	.....	.....

[a] Difference from the length on the right side.

After individual comparison, in the human adult, it is found that the relations of the combined fossal, and the ventral length, are as follows: Both measurements are alike on the two sides[a] in 14.7 per cent of cases. Both measurements are longer on the same side in 62.7 per cent of cases. One of the measurements is equal on the two sides, the other unequal, in 22.7 per cent of cases.

The instances where the measurements agree, either in that each is equal on the two sides of the skull, or in both being longer on the same side of the skull, constitute nearly four-fifths of the cases, so that agreement between the $a+m+ps$ length and the greatest ventral length on each side may be said to be almost general. Of the exceptions only a few are marked. The highest discrepancy was a 7 mm. difference in favor of the right combined fossal length in a case where the ventral lengths were equal.

The *interrelation* of the three cerebral cavities, shown hitherto only indirectly and incompletely, can be further brought out by comparing the lengths of the individual cavities with the sum of the lengths of the three, thus: $\frac{\text{length of } x \text{ fossa} \times 100}{\text{length of } a+m+ps^{b} \text{fossæ}}$. The results, which can be termed indexes, and are convenient for collation, are given, with three columns of supplemental comparisons, in the table below.

[a] Differences up to one millimeter between the whole right and left side being disregarded, as a possible error can not in such cases be excluded.

[b] That is, of anterior and middle and postero-superior fossæ.

Indexes showing the interrelation of the cranial (cerebral) fossæ.

Subjects.	Number of skulls.	Index[a] of anterior fossa.		Index[b] of middle fossa.		Index[c] of the cerebral part of the posterior fossa.		Middle[d] *vs.* anterior fossæ (mean).	Postero-superior[e] *vs.* middle fossa (mean).	Postero-superior[f] *vs.* mean of anterior and middle fossæ.
		Right.	Left.	Right.	Left.	Right.	Left			
Adults:										
Whites, males—										
Dolichocephals	14	28.1	27.4	29.0	28.8	42.9	43.8	104	150	152
Mesocephals	11	27.9	27.1	29.5	29.3	42.6	43.6	107	146	151
Brachycephals	11	27.7	26.8	30.5	30.6	41.9	42.6	112	138	146
Whites, females—										
Dolichocephals	5	28.0	27.1	29.5	28.6	42.5	44.1	105	149	153
Mesocephals	6	28.2	27.5	29.4	29.0	42.4	43.5	105	147	151
Brachycephals	6	27.9	27.5	29.3	29.3	42.8	43.2	106	147	151
Indians, males—										
Dolichocephals	10	26.1	25.7	29.7	28.7	44.1	45.7	113	154	163
Brachycephals	10	26.44	26.37	31.1	30.3	42.5	43.6	116	140	152
Negroes—										
Males, dolicho- and mesocephals	14	28.2	27.2	29.3	29.1	42.5	43.7	105	147	151
Females, dolicho- and mesocephals	5	29.1	28.0	28.4	28.3	42.4	43.7	99	152	151
Fetuses and young	40	29.7	29.4	27.7	27.5	42.5	43.1	93	155	150
Anthropoid apes:										
Chimpanzees	2	31.1*	30.2	30.6	30.4	38.3	39.4	99	127	126
Gorilla	1	27.7	27.1	31.2	29.6	41.1	43.3	111	138	146
Orangs	6	29.4	28.9	30.1	29.7	40.5	41.4	103	137	139
Gibbons	4	33.2	33.2	29.7	29.1	37.1	37.7	89	127	119
Monkeys, etc.:										
Cynocephalus	1	28.6	?	32.4	?	39.0	?	113	120	128
Macacus pelops	1	32.8	32.4	31.7	31.3	35.6	36.3	97	114	112
Cebus hypoleucus	1	31.1	30.7	31.8	32.0	37.1	37.3	103	116	118
Mycetes	1	31.3	?	35.4	?	33.3	?	113	94	100
Alouata senicula	1	31.7	31.1	35.9	34.5	32.4	34.5	112	95	100
Midas	1	28.9	29.2	33.3	34.8	37.8	36.0	117	108	117
Lemur varius	1	35.5	35.8	36.3	36.6	28.2	27.6	102	76	77
Ursus americanus	1	?	?	?	?	?	?	105	.....	.....
Deer	1	?	?	?	?	?	?	90	.....	.....
Pig	1	?	?	?	?	?	?	84	.....	.....

[a=length of anterior fossa; m=length of middle fossa; ps=length of postero-superior fossa.]

[a] $\frac{a \times 100}{a+m+ps}$ [b] $\frac{m \times 100}{a+m+ps}$ [c] $\frac{ps \times 100}{a+m+ps}$

[d] Mean length of anterior fossæ=100. [e] Mean length of middle fossæ=100. [f] Mean length of a anterior and m, middle fossæ $\left(\frac{a+m}{2}\right)=100$.

The middle fossæ are, it is seen, longer than the anterior ones in a large majority of the series; they are shorter than the anterior cavities in the negro females, the fetuses and young, the chimpanzees, gibbons, and the macaque. The longest middle fossæ in relation to the anterior ones exist in the Indians, gorilla, and several of the monkeys, while the shortest are found in the pig, the gibbons, and the human fetuses and young.

The length of the postero-superior cavities approximates one and a half times that of the anterior fossæ in all the series of human skulls; it is somewhat less in the anthropoid apes, much less in most of the monkeys, and least (only three-fourths of the length of the anterior cavities) in the lemur.

More simplified data are obtained by a comparison of the length of the postero-superior fossæ to the mean of the lengths of the anterior

and middle cavities. It is seen that the former exceed the latter in the proportion of 143–163 to 100 in the human crania, as 119–146 to 100 among the anthropoid apes, as 100–128 to 100 among the monkeys, and only as 77 to 100 in the lemur. The highest proportion among the human series (163 to 100) is found in the Indian male dolichocephals, the smallest (146 to 100) among the white male brachycephals and (150 to 100) in the young. Among anthropoid apes the highest proportion (146 to 100) exists in the gorilla, the smallest (119 to 100) in the gibbons; while among the monkeys similar extremes are represented by the baboon (128 to 100) and by the mycetes and alouata (100 to 100). It is striking how much zoological sequence there is in the distribution of these particular results of comparison. The position of the Indians, however, seems anomalous.

The indexes show many characteristics of the fossæ which have already been brought out in the comparisons of the length of the cavities with the lengths of the skull. To avoid repetitions and a possible confusion, these features are relegated to the general summary.

THE POSTERO-INFERIOR OR CEREBELLAR FOSSÆ.

The absolute average length of the cerebellar fossæ in the various series of human adults is as follows:

Posterior fossæ, cerebellar portion: Average length in adults.

Subjects.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Whites	(20) 63.4	(20) 62.5 a(−0.9)	(19) 62.6	(19) 62.7 a(+0.1)	(19) 62.8	(19) 62.9 a(−0.1)	(10) 58.5	(10) 58.4 a(−0.1)	(9) 61.6	(9) 61.2 a(−0.4)	(9) 59.7	(9) 59.8 a(+0.1
Indians	(10) 64.0	(10) 63.3 a(−0.7)	.....	.....	(10) 59.3	(10) 59.1 a(−0.2)	.....	.....	.....	.....	.....	.....
Negroes	(15) 62.9	(15) 63.9 a(+1.0)	.....	.....	.....	.....	(10) 60.0	(10) 59.4 a(−0.6)	.....	.....	.....	.....

a Differences from the right fossæ.

The right cavity, it is seen, exceeds the left in length in a pronounced manner in the white and Indian male dolichocephals, and a little less so in two of the female series, but is decidedly smaller in the male negro. In the brachycephals the differences are throughout immaterial. It is plain that correlation between the cerebellar and posterior cerebral cavities, if it exists at all, is very limited. During the measuring in whites it was very often noticed that the groove and ridges of the lateral sinus on the left side were lower than those on

the right, but this was not always associated with a smaller length of the left postero-inferior fossa.

In detail the differences in the cerebellar cavities were distributed thus:

Length of postero-inferior fossa on the two sides.

Skulls.	Right cerebellar fossa longer (per cent of cases).	Fossæ equal (per cent of cases).	Left cerebellar fossa longer (per cent of cases).
Adults:			
Whites, males—			
Dolichocephals	50	20	30
Mesocephals	53	11	37
Brachycephals	26	32	42
Whites, females—			
Dolichocephals	30	10	50
Mesocephals	33	33	33
Brachycephals	50	12	38
Indian, males—			
Dolichocephals	60	20	20
Brachycephals	60	0	49
Negroes—			
Males, dolicho- and mesocephals	33	7	60
Females, dolicho- and mesocephals	50	20	30
Human fetuses and young	25	38	35
Anthropoid apes	15	38	47
Monkeys and lemur	20	40	40

The results, so far as the human adults are concerned, agree in general with those shown by the first table of this part of the paper. There is a larger proportion of longer fossæ on the right than on the left side in the white and Indian male dolichocephals, and smaller in the male negroes. Greater numbers of crania, particularly brachycephalic, would have been very desirable in this connection. In the human young, anthropoid apes, and monkeys are seen relatively small percentages of longer right fossa, with larger percentages of longer left fossa and of equal cavities. Comparing the conditions found in the human young with those in adults, it is seen that in a large proportion of cases the excess in length in the right cerebellar fossa takes place after fetal life has been completed.

The absolute differences in length of the two cerebellar cavities were in some of the skulls quite marked, but on the whole were less than those of the postero-superior fossæ. They ranged as follows:

Absolute differences in length of the cerebellar fossæ; right fossa the longer in cases:

Subjects.	0.5 mm	1.0 mm.	1.5 mm.	2.0 mm.	2.5 mm.	3.0 mm.	3.5 mm.	4.0 mm.	4.5 mm.	5.0 mm.	Above 5.0 mm.
Human adults	9	13	5	7	8	5	4	4	1	1	.....
Human fetuses and young	4	6	.....	.....	.....	.....	.....	.....	.....	.....	.....
Anthropoid apes	0	0	0	1	1	.....	.....	.....	.....	.....	.....
Monkeys and other mammals	0	1	.....	.....	.....	.....	.....	.....	.....	.....	.....

Absolute differences in length of the cerebellar fossæ; left fossa the longer in cases:

Subjects.	0.5 mm.	1.0 mm.	1.5 mm.	2.0 mm.	2.5 mm.	3.0 mm.	3.5 mm.	4.0 mm.	4.5 mm.	5.0 mm.	Above 5.0 mm.
Human adults	9	13	6	7	4	5	1	1	2	1	a2
Human fetuses and young	2	5	3	2	1	0	0	1	.....	.....	.....
Anthropoid apes	1	1	1	2	0	0	1	.....	.....	.....	.....
Monkeys and other mammals	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....

a1=5.5 mm.; 1=11 mm.

In human adults the scales of inequalities are very nearly alike; in the fetuses, and to a lesser extent in the apes, the differences on the left side are more pronounced than those on the right.

The relation between the mean length of the cerebellar fossæ and the size of the skull (estimated on the base of the mean of the greatest cranial length and breadth) is indicated in the next table, the skulls represented being the same as with the cerebral fossæ in similar comparisons:

Average relation of the mean length of the two postero-inferior (cerebellar) fossæ to the greatest dorsal and mean ventral length of the skull (each of these diameters being taken as 100) in the largest and smallest skulls of the series.

Subjects.	Number of specimens.	In the largest crania—		Number of specimens.	In the smallest crania—	
		vs. external length.	*vs.* internal length.		*vs.* external length.	*vs.* internal length.
Adults:						
White males	6	33.4	36.2	6	34.1	37.0
White females	6	33.6	36.9	6	34.5	37.6
Indian males	6	35.5	38.8	6	35.0	37.9
Negroes, both sexes	5	32.8	36.3	5	35.7	38.8

Except in the Indian males, the fossæ in the smallest crania are in all the groups relatively longer than those in the largest skulls of the series, which means that the cerebellum increases in length in a slightly lower ratio than the skull. It is rather remarkable that the negroes show in this respect, as on many former occasions, nearer the whites than the Indians, while in many external features of the skull the Indians are intermediary between the two.

The absolute and relative length proportions of the cerebellar fossæ, contrasted between adults and young, man and animals, sexes, races, and in the main cranial forms, are as follows:

Length proportions of postero-inferior fossæ in relation to greatest external and mean internal length of the skull.

Subjects.	Number of skulls.	Average external maximum length of skull.	Average mean length of the 2 postero-inferior fossæ.	Average relation of the length of the fossæ to the dorsal length of the skull.	Average relation of the length of the fossæ to the ventral length of the skull.	Number of skulls.
Adults:						
Whites, males—		*cm.*	*mm.*			
Dolichocephals	14	19.4	63.4	33.0	35.7	10
Mesocephals	11	18.7	63.7	34.0	36.4	14
Brachycephals	11	18.2	62.9	34.4	37.5	10
Whites, females—						
Dolichocephals	5	17.8	58.6	32.9	35.6	10
Mesocephals	6	17.8	61.1	34.4	37.0	9
Brachycephals	6	17.3	60.4	35.0	38.2	5
Indians, males—						
Dolichocephals	10	18.3	63.6	34.8	38.2	10
Brachycephals	10	16.9	59.2	34.9	38.5	10
Negroes:						
Males, dolicho- and mesocephals	14	18.6	63.9	34.4	37.9	13
Females, dolicho- and mesocephals	5	17.7	60.3	34.1	37.1	8
White fetuses and children, brachycephals	10	.....	27.2	36.0	38.0	8
Colored fetuses and children:						
Brachycephals	10	.....	32.2	35.0	36.4	10
Dolicho- and mesocephals	20	.....	32.2	33.3	35.1	20
Anthropoid apes:						
Chimpanzees	2	11.9	42.8	36.0	38.8	2
Orangs	6	11.9	41.2	34.5	39.1	6
Gibbons	4	7.5	24.6	32.6	33.8	4
Monkeys and lemurs:						
Macacus pelops	1	8.2	24.0	29.2	31.2	1
Cebus hypoleucus	1	7.5	18.7	25.0	28.0	1
Alouata senicula	1	7.0	20.5	29.3	34.9	1
Midas	1	4.1	11.5	28.0	29.3	1
Lemur varius	1	6.0	16.0	26.7	30.2	1

The average relative proportions of the cerebellar fossæ differ, it is seen, but little between human adults and human young, both groups taken as a whole. If the cases are taken individually, it is found that there is a greater variation in the relative proportions of the cavities in the fetuses and young than in the adults (young, 27.2–47.2; adults, 28.8–40.1; in the young, proportions below 30 in 9 per cent and above 40 in 5.1 per cent of the fossæ, in adults, those below 30 in 1.5, those above 40 in 0.4 per cent of the cavities). These greater inequalities in the young are in all probability due more to the relatively abundant tissues about and especially in the rear of the cerebellum than to variation in the hind-brain itself. The volume itself of the fetal cerebellar fossæ would be smaller were these tissues not present, and their relative length would not equal that in the adults. Among anthropoid apes the relative dimensions of the cerebellar fossæ in the chimpanzee and orang are much like those in some of the series of human adults, but those in the gibbon are noticeably lower, and they are still lower, with one exception, in the monkeys and lemur.

The adult human cerebellum is, therefore, relatively somewhat longer than it is in gibbons and lower primates.

Sexual differences are insignificant in the whites as well as the negroes.

As to racial differences, there is a slight excess in the relative length of the cerebellar fossæ (as there was with the postero-superior ones) in favor of the Indians. Again in this instance the negroes appear nearer to the whites than the Indians.

Finally, the data show the existence of decided differences in the relative length of the cerebellar fossæ between the main cranial forms; the proportion is throughout, even in the young, greater in the brachycephals than in the dolichocephals. A somewhat similar condition was seen also with the postero-superior cavities.

The relation of the length of the cerebral to that of the cerebellar portion of the posterior fossæ is shown in the last table of this section. In conformity with the separate data concerning the two cavities, the cerebellar fossa is seen to be relatively longer in all the brachycephals than in the dolichocephals. In the dolicho- and mesocephalic fetuses and young the cerebellar fossa is relatively shorter than in the adults; in the orangs and gibbons the relation of the two cavities is nearly as that in man, but in most of the monkeys it shows larger differences. In the lemur, finally, the superior part of the fossa shows but a slight excess over the inferior.

Relation of the length of the cerebellar to that of the posterior cerebral (postero-superior) fossæ.

Subjects.	Number of skulls.	Proportion, the cerebellar fossæ=100.
Adults:		
Whites, males—		
Dolichocephals	20	129
Mesocephals	19	127
Brachycephals	19	124
Whites, females—		
Dolichocephals	10	129
Mesocephals	9	126
Brachycephals	8	125
Indians, males—		
Dolichocephals	10	127
Brachycephals	10	125
Negroes—		
Males, dolicho- to mesocephals	15	124
Females, dolicho- to mesocephals	10	126
Fetuses and young:		
Dolicho- and mesocephals	20	134
Brachycephals	19	126
Anthropoid apes:		
Chimpanzees	2	116
Gorilla	1	140
Orangs	6	124
Gibbons	4	125
Monkeys, etc.:		
Cynocephalus	1	158
Macacus pelops	1	135
Cebus hypoleucus	1	149
Myctes	1	140
Alouata senicula	1	120
Midas	1	143
Lemur varius	1	108

SUMMARY OF THE RESULTS OF MEASUREMENTS OF THE CRANIAL FOSSÆ.

Results obtained from the absolute measurements and by comparing the length of the fossæ with the dorsal and ventral lengths of the skull.	Results obtained by comparing the length of the fossæ with their combined length, and among themselves.
ANTERIOR FOSSÆ.[a]	ANTERIOR FOSSÆ.[a]
1 (*a*) The average absolute length of the right cavity is somewhat greater than that of the left in all the human series, in all the anthropoid apes except the gibbons, and in some other primates and lower mammals.	1 (*a*) The average absolute length of the right cavity is somewhat greater than that of the left in all the human series, in all the anthropoid apes except the gibbons, and in some other primates and lower mammals.
(*b*) Individually, the largest percentage of longer right fossæ and the most pronounced differences between the length of the two cavities occur in the human adults, and then in the higher anthropoid apes (chimpanzee, gorilla, orang).	(*b*) Individually, the largest percentage of longer right fossæ and the most pronounced differences between the length of the two cavities occur in the human adults, and then in the higher anthropoid apes (chimpanzee, gorilla, orang).
2. There is a prevalence of relatively short anterior fossæ in the largest, and of relatively long fossæ in the smallest skulls.	
3 (*a*) The mean length of the anterior cavities is relatively greater in the human fetuses and young than it is in human adults.	3 (*a*) The mean length of the anterior cavities is relatively greater in the human fetuses and young than it is in human adults.
(*b*) It is also greater in most of the primates and other mammals examined than in the human adults.	(*b*) It is also greater in most of the primates and other mammals examined than in the human adults.
(*c*) It is slightly greater in the human adult females than in the males.	(*c*) But little difference in whites; length greater in negro females than in males.
(*d*) It is nearly alike in the whites and the negroes, but is smaller in the Indians; and, finally,	(*d*) Smaller in the Indians; slightly greater in the negroes than in whites.
(*e*) It it slightly smaller in the dolicho- than in the brachycephalic skulls.	(*e*) Somewhat greater in the dolichocephalic male whites, smaller in the dolichocephalic Indians, than in brachycephals.
MIDDLE FOSSÆ.	MIDDLE FOSSÆ.
1 (*a*) The average absolute length of the right cavity is slightly greater than that of the left in a large majority of the human series and in the anthropoid apes, while in the other primates and mammals the two fossæ are in average about equal.	1 (*a*) The average absolute length of the right cavity is slightly greater than that of the left in a large majority of the human series and in the anthropoid apes, while in the other primates and mammals the two fossæ are in average about equal.
(*b*) Individually, the largest percentage of longer right middle fossæ and the most pronounced differences between the length of the cavities occur in several series of the human adults (in the dolichocephals), and then in the anthropoid apes.	(*b*) Individually, the largest percentage of longer right middle fossæ and the most pronounced differences between the length of the cavities occur in several series of the human adults (in the dolichocephals), and then in the anthropoid apes.
(*c*) Compensation in length with the anterior fossæ appears possible in only a limited proportion of cases. In one-third of the skulls the middle cavity was greater in length on the same side as the anterior.	
2. The differences in the relative length of the middle fossæ between the largest and smallest skulls are not well defined.	
3 (*a*) The mean length of the middle cavities is, relatively, smaller in the human young than in adults.	3 (*a*) The mean length of the middle cavities is, relatively, smaller in the human young than in adults.
(*b*) It is greater than in the adult man in the anthropoid apes, and especially so in the monkeys and other mammals.	(*b*) Slightly greater in some anthropoid apes, decidedly greater in monkeys and lemur (also in other mammals examined) than in man.

[a] It should be borne in mind that the two headings represent not equal, but only cognate, aspects of the case, mathematically as well as morphologically. This accounts for the several differences that will be observed.

Summary of the results of measurements of the cranial fossæ—Continued.

Results obtained from the absolute measurements and by comparing the length of the fossæ with the dorsal and ventral lengths of the skull.	Results obtained by comparing the length of the fossæ with their combined length, and among themselves.
MIDDLE FOSSÆ—continued.	MIDDLE FOSSÆ—continued.
(*c*) Differences are quite immaterial in whites, though there is a tendency to smaller relative proportions in the females: in negroes, smaller in the females.	(*c*) Fossæ smaller in the female negro.
(*d*) Differences quite immaterial, though somewhat smaller than in any other adult human series in the female negro.	(*d*) Fossæ somewhat smaller in the negroes of both sexes than in other human adults
(*e*) The relative length of the middle fossæ is throughout smaller in the dolicho- than in the brachycephals.	(*e*) The relative length of the middle fossæ is throughout smaller in the dolicho- than in the brachycephals.
CEREBRAL PART OF THE POSTERIOR FOSSÆ.	CEREBRAL PART OF THE POSTERIOR FOSSÆ.
1 (*a*) The average absolute length of the right cavity is decidedly shorter than that of the left side in all the series of human adults and anthropoid apes, moderately shorter in the human young, and slightly shorter in the lower primates and other animals.	1 (*a*) The average absolute length of the right cavity is decidedly shorter than that of the left side in all the series of human adults and anthropoid apes, moderately shorter in the human young, and slightly shorter in the lower primates and other animals.
(*b*) Individually, the largest percentage of longer left fossæ and the most pronounced differences between the length of the two cavities occur (as with the anterior and middle fossæ) in the human adults, and then in anthropoid apes.	(*b*) Individually, the largest percentage of longer left fossæ and the most pronounced differences between the length of the two cavities occur (as with the anterior and middle fossæ) in the human adults, and then in anthropoid apes.
(*c*) The length of the posterior fossa stands frequently in compensatory relation with the combined length of the anterior and middle fossæ on the same side.	
There are no regular or large differences in the relative length of the postero-superior fossæ between the largest and smallest skulls.	
3 (*a*) The mean relative length of the postero-superior cavities, compared with the mean ventral antero-posterior diameter of the skull, is, in the human fetuses and young, slightly greater than in some series of the adults and smaller than in others.	3 (*a*) The left fossa in the young shows smaller, the right about equal index, as compared with that in adults; contrasted with the combined length of the anterior and middle fossæ, it appears smaller than in the adults.
(*b*) It is smaller than in adult man in anthropoid apes (except the orang), monkeys, and especially in the lemur.	(*b*) It is smaller than in adult man in anthropoid apes (except the orang), monkeys, and especially in the lemur.
(*c*) There is no material difference between the sexes.	(*c*) There is no material difference between the sexes.
(*d*) From the racial point of view, the length is relatively greatest in the Indians; it is nearly alike in the whites and the negroes; finally,	(*d*) From the racial point of view, the length is relatively greatest in the Indians; it is nearly alike in the whites and the negroes; finally,
(*e*) It is greater in the brachycephals than in the dolichocephals among the whites, but smaller in the former than in the latter among the Indians.	(*e*) The index is somewhat greater in all but one of the series of dolichocephals than in the brachycephals, and comparison of the length of the postero-superior fossæ with that of the anterior and middle fossæ, shows excess for dolichocephals in all the series.

The combined length of the three cerebral fossæ is greater on the left in from 64 to 80 per cent of the adult dolicho- and mesocephals, but there is a prevalence of greater length on the right side in the brachycephals, the young and the primates.

CEREBELLAR FOSSÆ.

1 (*a*) The right cavity shows a greater average absolute length in adult white males and in the Indian male dolichocephals, but is shorter than the left in the adult male as well as in female negroes. Among brachycephals, white and Indian, the differences are immaterial.

(*b*) In human fetuses and young in anthropoid apes, monkeys, and lemurs the left fossa is more often the longer.

(*c*) Correlation between the length of the cerebellar and any of the individual cerebral fossæ is nil, or very limited.

2. In the largest skulls the cerebellar fossæ are relatively shorter than in the smallest crania.

3 (*a*) The mean length of the cerebellar cavities is, relatively, somewhat smaller in the human young than in adults.

(*b*) It is like in man in the chimpanzee and orang, but is smaller in the gibbon, and especially so in the monkeys and lemur.

(*c*) Sexual differences are quite immaterial.

(*d*) As to races, the fossæ are relatively nearly alike in the whites and the negroes, but are longer in the Indians; finally,

(*e*) The relative length of the cerebellar fossæ is greater in all the series of brachycephals than in dolichocephals.

With all the four fossæ, and in all series, that cavity which is more often the longer than its mate of the opposite side shows generally also a larger range of the excesses of measurement.

If the above results of the studies on the skull are now applied to the brain itself, i. e., to those parts of the brain represented by the measurements taken, the indications are that—

In human adults, in general, the cerebrum presents in the majority of cases a greater basal length (as obtained by the measurements here dealt with) on the left side; the length of the frontal lobe is somewhat greater on the right than on the left side; the length of the parietal lobe is slightly greater than that of the frontal, and in most instances is also slightly greater on the right than on the left side; compensation in length with the frontal lobe appears to be very limited; the length of the occipital lobe is decidedly greater than that of the frontal or that of the parietal lobe (with the former as nearly 1.5 to 1, with the latter as over 1.5 to 1); and it is decidedly greater, in a large majority of brains, on the left side; there exists frequently a compensation in length between the two more anterior lobes and the occipital; the length of the cerebellum is smaller than that of the occipital lobe, but is always in excess of that of either the anterior or the middle lobe of the cerebrum; the right lobe shows in some of the series (whites) a prevalence of greater length on the right side; in others (negroes) on the left side; no correlation appears between the length of the cerebellum and that of the occipital, or any other portion of the cerebrum; the largest adult human brain shows a relatively smaller length of the anterior lobes than do the smallest specimens; with other portions of the organ the differences in this respect are irregular.

In human fetuses and young in general, the relative length of the anterior lobes is greater than that in adults; the average length of the right lobe is already somewhat greater than that of the left, but individually there are many more cases than in the adults in which the two are equal; the length of the parietal lobes is smaller than that of the frontal (a reverse condition from that found in adults); the right lobe is the longer more often than the left, but in one-half of the specimens they are equal; the relative length of the parietal lobes is less than in adults; the relative length of the occipital lobes, or at least of that on the left side, is slightly smaller than the general average in adults; there is a prevalence of longer left lobe, but the proportion of equally long lobes is larger than among the adults; the relative length of the cerebellum is somewhat smaller than in adults; and the left lobe is more often the longer.

In the anthropoid apes, monkeys, and other mammals (so far as represented), the relative length of the frontal lobes is, with a few exceptions, greater than in human adults and often greater even than in human young; the right lobe is probably longer in all the apes except gibbons, and was found longer individually also in some of the other primates and mammals (the differences being greatest in the higher apes); the length of the parietal lobes is greater than that of the frontal in the gorilla and orangs, and in several of the monkeys, but is smaller in the gibbons, macaque, deer, and particularly in the pig; the right lobe is prevalently the longer among the anthropoid apes only; the relative length of the lobes is greater in anthropoid apes, and especially in the monkeys and other mammals, than it is in adult man; the relative length of the occipital lobe is smaller in anthropoid apes than in man, and still smaller in the monkeys and lemurs; in mycetes, alouata, and especially in lemur, it is shorter than either the frontal or parietal lobe; the left lobe is prevalently the longer in the apes and among monkeys, but was found shorter than the right in midas and lemur; the relative length of the cerebellum is somewhat greater than in adult man in the chimpanzee and orangs, but is smaller in the gibbons and other primates with lemurs.

Sexual differences in the brain are, so far as here dealt with, but few in number and not large. Relatively the anterior lobes are slightly longer in the females than in the males, and there is apparently some correlated tendency in the females, especially in the negroes, to smaller relative length of the parietal lobes.

Racial brain differences indicated by the results of this study are as follows: The relative length of the anterior lobes is smaller in the Indians than in the whites and negroes (in whom it is nearly alike); the middle lobes are relatively smaller in the female negro than in any other series of human adults; the occipital portions are relatively longer in the Indians than in the whites and negroes (in whom they are

nearly alike); the cerebellum shows the prevalence of a greater length of the left lobe (in some whites and Indians right lobe); and the length of the hindbrain is relatively more considerable in the Indian than in the white or negro (in whom it is nearly alike).

Finally, as to brain differences in the principal forms of the skull, it was found that the relative length of the frontal lobes is somewhat smaller in the dolicho- than in the brachycephals; the relative length of the parietal lobes is throughout smaller in the dolicho- than in the brachycephals; the relative length of the occipital portions of the cerebrum is on the whole larger in the dolichocephals (see indexes of the fossæ and comparison of the length of the postero-superior fossa with that of the anterior and middle cavities); finally, in the cerebellar length, the dolichocephals show more difference on the two sides than the brachycephals, but the brachycephals show throughout a greater relative length of the hindbrain than the dolichocephals.

On the basis of this study the following characteristics of the adult human skull or brain may be viewed as of lower developmental order: A large relative length of the frontal fossæ, or frontal lobes (infantile and animal feature); a small relative length of the middle fossæ, or parietal lobes (infantile feature); a small relative length of the cerebral part of the posterior fossa, or the portion of the cerebrum it contains (infantile and animal feature), and a smaller relative length of the cerebellar fossa, or the cerebellum (infantile and animal feature).

Looking at the series of examined skulls in this light, the male skulls show a little more favorably than the female; racially we are confronted with the curious and most unexpected fact of the quite close position of the whites and negro males and a more advanced differentiation of the Indian over both, while as to cranial types the dolichocephals show some developmental superiority in the frontal and postero-superior fossæ and corresponding lobes, the brachycephals in the middle fossæ, or lobes, and in the relative length of the whole cerebrum.

Much larger series of specimens would very likely accentuate many, and probably modify a few, of the results obtained with the numbers available to the writer. It is to be hoped further opportunities in this respect will arise and be utilized here or elsewhere with other investigations in the future. Measurements on the brain itself could, perhaps, take to some extent the place of those on the fossæ, though more confidence must remain with the latter, which are not subject to deformation.

EXTERNAL LENGTH OF SKULL COMPARED WITH THE INTERNAL.

There are several items of interest which were inquired into in connection with the preceding study.

One of these is the relation in the several series between the greatest external and the greatest mean internal length of the skull. The comparison given in the succeeding table shows a slight excess in the thickness of the skull in the white brachycephals over that in the white dolichocephals; a slight excess in the Indians over whites; and an appreciable excess in the negroes over the Indians. These differences explain better than has been done heretofore the discrepancies noticed between the comparisons of the cranial fossæ with the dorsal and ventral lengths, and demonstrate the greater suitability of the latter for such a function.

Diameter antero-posterior maximum of the skull dorsally compared with mean diameter antero-posterior maximum ventrally.

Subjects.	Males.						Females.					
	Dolichocephals.		Mesocephals.		Brachycephals.		Dolichocephals.		Mesocephals.		Brachycephals.	
	D. a-p. m.	D. a-p. m'n (ventr.)	D. a-p. m.	D. a-p. m'n (ventr.)	D. a-p. m.	D a-p. m'n (ventr.)	D. a-p. m.	D. a-p. m'n (ventr.)	D. a-p. m.	D. a-p. m'n (ventr.)	D. a-p. m.	D. a-p. m'n (ventr.)
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Whites.	(8) 19.1	17.7 a(−1.4)	(12) 18.7	17.3 a(−1.4)	(9) 18.2	16.7 a(−1.5)	(7) 17.8	16.6 a(−1.2)	(6) 17.8	16.5 a(−1.3)	(4) 17.3	15.9 a(−1.4)
Indians	(10) 18.3	16.7 a(−1.6)	.....	.....	(10) 16.9	15.4 a(−1.5)	.....	.....	.....	.....	.....	.....
Negroes	(13) 18.5	16.8 a(−1.7)	.....	.....	.....	.....	(7) 17.9	16.2 a(−1.7)	.....	.....	.....	.....

a Difference from dorsal length.

In order to see how other lengths of the anterior fossæ, and especially their relation to the ventral length of the skull, agree with the measurement chosen and its relations, the writer secured also in most of the specimens utilized the distance from the foramen cœcum to the anterior boundary of the pituitary fossa. The table beneath gives the results and these, it will be seen, express much the same conditions as were found with the regular measurement of the frontal cavity. There is (except in the white females where the small number of specimens is evidently at fault) again a predominance of the length in the brachycephals over that in the dolichocephals, and there are seen

again the smaller relative proportions of the measurement in the Indians than in the whites and negroes of a similar head form. A disadvantage to this measurement consists in the variation in the region just anterior to the pituitary fossa.[a]

FORAMEN CŒCUM TO PITUITARY FOSSA.

Length from foramen cœcum to pituitary fossa.

Subjects.	Adult males.			Adult females.		
	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Whites	(20) 5.06	(20) 4.90	(20) 4.82	(8) 4.78	(8) 4.78	(8) 4.70
Indians	(10) 4.51		(10) 4.44			
Negroes	(15) 4.76			(10) 4.61		

Relation of length from foramen cœcum to pituitary fossa, to the mean ventral cranial length (the latter = 100).

Subjects.	Adult males.			Adult females.		
	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.
Whites	(11) 28.2	(14) 28.4	(10) 29.8	(8) 29.1	(7) 29.2	[a]28.1
Indians	(10) 27.2		(10) 28.9			
Negroes	(13) 28.7			(8) 28.6		

[a] 4 cases only.

GREATEST VENTRAL FRONTAL BREADTH.

Finally, an effort was made to measure the greatest frontal ventral diameter corresponding to the greatest breadth of the frontal lobe. This measurement could be more profitably taken on the brain itself, or on casts of the frontal part of the cranium. There is found in almost every skull, on each side, and just anterior to the coronal suture, a marked depression, which probably corresponds to the greatest expanse of the frontal lobe, but definite landmarks from which to measure are lacking. Notwithstanding this difficulty, certain interesting results have been arrived at, namely:

[a] See A. Hrdlicka, Dimensions of the Normal Pituitary Fossa in the White and the Negro Races; Arch. of Neurology and Psychopathology, Utica, N. Y., I, No. 4, 1898.

Breadth, maximum, of frontal region (ventrally).

Subjects.	Adult males.			Adult females.		
	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.
	cm.	cm.	cm.	cm.	cm.	cm.
Whites	(17) 9.9	(16) 10.5	(15) 10.8	(6) 9.3	(8) 9.6	(5) 10.0
Indians	(6) 9.7		(3) 10.8			
Negroes	(14) 10.2			(10) 9.7		

Breadth, maximum, of frontal region, ventrally, compared with breadth maximum of the skull dorsally.

Subjects.	Adult males.			Adult females.		
	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.	Dolicho-cephals.	Meso-cephals.	Brachy-cephals.
Whites	(17) 71.3	(16) 71.9	(15) 70.6	(6) 71.5	(8) 70.0	(5) 71.0
Indians	(6) 71.9		(3) 73.0			
Negroes	(14) 73.3			(10) 72.6		

Fetuses and young, both sexes:
- White, brachycephalic (6) 80.9
- Colored—i. e., negro and negro-white—
  - Brachycephalic (10) 80.7
  - Dolicho- and mesocephalic (20) 82.3

Apes—
- 1 chimpanzee 79.8
- 6 orangs 77.8
- 4 gibbons 79.2

Monkeys—
- 1 *Macacus pelops* 79.4
- 1 *Alouata seniculi* 78.6
- 1 *Cebus hypoleucus* 79.3
- 1 *Lemur varius* 80.5
- 1 *Ursus americanus* 75.3

At first sight the above data are quite striking, but it must be remembered that the frontal breadth has been compared with the dorsal breadth of the skull, which varies in the different series. The proper way would be to compare the former with the greatest ventral breadth in all the skulls, but the latter measurement is difficult and in the material here utilized was not always possible.

The thickness of the skull is very nearly the same in human fetuses and young, in gibbons, alouata, cebus, and lemur, and the data obtained on these specimens are directly comparable.

In the orangs and chimpanzees the thickness of the two parieties at the location of the greatest breadth of the skull exceeds that in the human young by about 5 mm., in the negro by about 7 mm., in the Indian and white male by about 6 mm., and in the white female by about 5 mm. Reducing the greatest external breadth of the skulls in question by these figures and comparing the greatest internal frontal breadth with the remaining proportions, we obtain the following data, which are quite suitable for comparisons with the human young, gibbons, and other above-named species.

The greatest ventral frontal breadth compared with greatest breadth of the skull (reduced), the latter taken as 100.

Adult white males	74.3	Chimpanzees	75.0
Adult white females	73.5	Orangs	77.8
Adult Indians	75.6	Gibbons	79.2
Adult negroes	76.9	Monkeys	79.0
Human fetuses and young	81.6	Lemur	80.5

It appears that the difference between the greatest breadth of the frontal lobes and the greatest breadth of the skull, or, respectively, of the cerebrum, is less in the lemur and in most of the lower primates, as well as in the human fetuses and young, than it is in human adults, particularly among whites. With all their imperfections, these determinations point to another line of anthropometric studies on the brain, promising interesting results.

The detail tables of measurement of the cranial fossæ are appended to facilitate control of the preceding data, as well as the utilization of the series for future studies; and to show the individual variations which could not be dealt with conveniently in the text.

DETAILED DATA.

Summary of absolute and relative lengths of the cranial fossæ.

Subjects.	Average dorsal antero-posterior maxim. diameter of skulls.	Absolute lengths.				Ratio of length of fossæ to greatest dorsal length of skull.				Ratio of length of fossæ to mean ventral length of skulls.			
		Anterior fossæ.	Middle fossæ.	Postero-superior fossæ.	Cerebellar fossæ.	Anterior fossæ.	Middle fossæ.	Postero-superior fossæ.	Cerebellar fossæ.	Anterior fossæ.	Middle fossæ.	Postero-superior fossæ.	Cerebellar fossæ.
Adults:													
Whites, males—	*cm.*	*mm.*	*mm.*	*mm.*	*mm.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Dolichocephals	19.4	52.7	54.9	82.1	63.4	27.3	28.3	42.4	33.0	29.3	31.9	45.9	35.7
Mesocephals	18.7	51.5	55.2	80.7	63.7	27.5	29.4	43.0	34.0	29.5	32.2	46.0	36.4
Brachycephals	18.2	49.8	55.9	77.3	62.9	27.3	30.7	42.4	34.4	29.6	33.9	46.4	37.5
Whites, females—													
Dolichocephals	17.8	48.2	51.0	75.9	58.6	27.1	28.6	42.6	32.9	29.4	31.4	45.8	35.6
Mesocephals	17.8	49.7	52.4	76.9	61.1	28.1	29.5	43.3	34.4	30.4	33.0	46.8	37.0
Brachycephals	17.3	48.6	51.4	75.3	60.4	28.2	29.8	43.5	35.0	30.0	32.0	47.4	38.2
Indians, males—													
Dolichocephals	18.3	46.6	52.5	80.8	63.6	25.5	28.7	44.2	34.8	28.0	31.5	48.5	38.2
Brachycephals	16.9	45.4	52.7	73.8	59.2	26.8	31.2	43.6	34.9	29.5	34.3	48.0	38.5
Negroes—													
Males, dolicho- and meso-cephals	18.6	50.6	53.5	78.7	63.9	27.3	28.8	42.4	34.4	30.4	31.9	46.7	37.9
Females dolicho- and meso-cephals	17.7	50.2	49.7	75.5	60.3	28.3	28.1	42.7	34.1	31.0	31.1	46.9	37.1
Human fetuses and young	9.1	28.1	26.2	41.1	30.9	30.8	28.8	44.5	34.1	32.5	30.2	46.9	36.1
Apes:													
Chimpanzees	11.9	39.0	38.5	49.8	42.8	32.9	32.3	41.7	36.0	35.3	34.8	45.0	38.8
Gorilla		38.7	43.0	59.7	42.7								
Orangs	11.9	36.2	37.1	51.0	41.2	30.4	31.1	42.8	34.5	34.4	35.3	48.5	39.1
Gibbons	7.5	27.3	24.2	30.8	21.6	36.2	32.0	40.7	32.6	37.5	33.2	42.3	33.8
Monkeys and lemurs:													
Macacus pelops	8.2	29.5	28.5	32.5	24.0	36.0	34.7	39.6	29.2	38.3	37.0	42.2	31.2
Cebus hypoleucus	7.5	23.2	24.0	28.0	18.7	30.0	32.0	37.3	25.0	34.7	35.8	41.8	28.0
Alouata senicula	7.0	23.0	25.7	24.5	20.5	32.9	36.8	35.0	29.3	39.1	43.8	41.7	34.9
Midas	4.2	13.0	15.2	16.5	11.5	31.7	37.2	40.2	28.0	33.1	38.8	42.0	29.3
Lemur varius	6.0	22.0	22.5	17.2	16.0	36.7	37.5	28.7	26.7	41.5	42.4	32.5	30.2

Cranial fossæ (ventral). Adult males, whites, dolichocephals (cephalic index below 75).

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cæcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
39.5, 1894–95	(C.U.)[a]	Ireland	19.60	13.60	*69.39*	5.40	5.30	*28.13*	*27.60*	5.60	5.60	*29.17*	*29.17*	8.20	8.30	*42.71*	*43.23*	19.20	19.20	18.05	(?)	4.7	10.0	6.50	6.45
	(C.U.)	(?)	20.40	14.30	*70.10*	5.50	5.80	*27.02*	*28.50*	5.80	5.75	*29.44*	*28.26*	8.40	8.80	*42.64*	*43.24*	19.70	20.35	(?)	(?)	5.2	10.7	6.70	6.80
540	(C.U.)	Ireland	19.90	14.05	*70.60*	5.25	5.15	*27.27*	*26.21*	5.40	5.50	*28.05*	*27.99*	8.60	9.00	*44.67*	*45.80*	19.25	19.65	18.40	18.50	4.9	10.2	6.30	5.95
1092x	(C.U.)	(?)	19.40	13.90	*71.65*	(?)	5.25	(?)	*28.07*	(?)	5.60	(?)	*29.95*	7.70	7.85	(?)	*41.98*	(?)	18.70	(?)	(?)	5.1	(?)	6.00	5.80
1070x	(C.U.)	(?)	19.50	14.00	*71.79*	5.60	5.30	*29.17*	*28.34*	4.90	5.00	*25.52*	*26.74*	8.70	8.40	*45.31*	*44.92*	19.20	18.70	(?)	(?)	4.6	9.4	6.10	6.10
8.4, 1895–96	(C.U.)	(?)	19.90	14.30	*71.86*	5.45	5.30	*28.38*	*27.39*	5.75	5.50	*29.95*	*28.42*	8.00	8.55	*41.67*	*44.18*	19.20	19.35	18.25	18.55	5.2	10.5	6.50	6.75
581	(C.U.)	United States	19.40	14.00	*72.16*	5.30	(?)	*27.46*	(?)	5.70	(?)	*29.53*	(?)	8.30	7.50	*43.01*	(?)	19.30	(?)	(?)	17.40	5.0	(?)	6.45	5.95
36.3, 1895–96	(C.U.)	(?)	19.40	14.00	*72.16*	(?)	5.30	(?)	*28.65*	(?)	5.40	(?)	*29.19*	8.60	7.80	(?)	*42.16*	(?)	18.50	(?)	(?)	4.8	9.7	6.90	6.60
29.4, 1896–97	(C.U.)	(?)	19.90	14.40	*72.36*	5.40	5.40	*27.98*	*28.72*	5.60	5.30	*29.02*	*28.19*	8.30	8.10	*43.01*	*43.08*	19.30	18.80	(?)	(?)	5.3	10.3	6.60	6.20
	(C.U.)	(?)	18.70	13.60	*72.73*	5.10	5.10	*27.06*	*26.91*	5.10	5.20	*27.06*	*27.44*	8.65	8.65	*45.89*	*45.65*	18.85	18.95	(?)	(?)	5.1	9.9	6.95	6.95
23.1, 1898–99	(C.U.)	United States	19.40	14.15	*72.94*	5.35	5.10	*28.45*	*26.42*	5.75	5.85	*30.58*	*30.31*	7.70	8.35	*40.96*	*43.26*	18.80	19.30	(?)	(?)	5.2	9.9	6.15	5.90
1108x	(C.U.)	(?)	19.60	14.30	*72.96*	5.40	5.25	*29.03*	*27.56*	5.65	5.55	*30.37*	*29.13*	7.55	8.25	*40.59*	*43.31*	18.60	19.05	17.45	17.85	5.2	10.3	6.05	6.30
1082x	(C.U.)	(?)	18.70	13.65	*73.00*	(?)	4.80	(?)	*25.67*	5.60	5.60	(?)	*29.95*	7.80	8.30	(?)	*44.38*	(?)	18.70	16.75	17.10	5.0	10.0	6.20	6.30
32.1, 1895–96	(C.U.)	Ireland	18.75	13.70	*73.06*	5.40	5.10	*29.92*	*28.17*	5.45	5.45	*30.19*	*30.11*	7.20	7.55	*39.89*	*41.71*	18.05	18.10	(?)	(?)	5.1	9.3	5.85	5.90
609	(C.U.)	Scotland	19.25	14.10	*73.25*	5.20	5.15	*27.27*	*27.74*	5.25	5.55	*27.48*	*28.24*	8.65	8.65	*45.29*	*44.02*	19.10	19.65	18.00	18.10	4.8	10.4	6.65	6.65
1103x	(C.U.)	(?)	19.40	14.25	*73.45*	(?)	5.50	(?)	*28.49*	(?)	5.75	(?)	*29.79*	7.90	8.05	(?)	*41.71*	(?)	19.30	(?)	(?)	5.2	(?)	6.50	6.40
3.4, 1896–97	(C.U.)	United States	18.00	13.30	*73.89*	4.70	4.55	*26.55*	*25.71*	5.00	5.00	*28.24*	*28.24*	8.00	8.15	*45.19*	*46.04*	17.70	17.70	16.60	16.50	4.7	9.3	6.20	6.20
689	(C.U.)	.....do.....	18.80	13.90	*73.94*	5.05	(?)	*27.26*	(?)	6.20	6.20	*33.51*	(?)	7.25	7.40	*39.19*	(?)	18.50	(?)	17.35	17.50	5.3	9.6	5.90	5.80
17.4, 1895–96	(C.U.)	(?)	19.40	14.30	*74.09*	5.30	5.35	*28.34*	*28.53*	5.70	5.70	*30.48*	*30.40*	7.70	7.70	*41.18*	*41.06*	18.70	18.75	17.45	17.45	4.9	10.0	5.90	6.00
1016x	(C.U.)	(?)	18.70	13.90	*74.33*	5.30	5.10	*27.80*	*26.84*	5.90	5.80	*31.05*	*30.53*	7.80	8.10	*41.05*	*42.63*	19.00	19.00	17.05	(?)	4.9	9.8	6.45	6.00
Average (14)[b]			19.4	14.0	*72.3*	5.31	5.23	*28.1*	*27.4*	5.49	5.48	*29.0*	*28.8*	8.10	8.32	*42.9*	*43.8*	18.90	19.04	17.53	17.69	5.06	9.9	6.31	6.25
Minimum (14)			18.0	13.3	*69.4*	4.7	4.5	*26.5*	*25.7*	4.9	5.0	*25.5*	*26.7*	7.2	7.5	*39.9*	*41.1*	17.7	17.7	16.6	16.5	4.6	9.3	5.8	5.8
Maximum (14)			20.4	14.4	*74.3*	5.6	5.8	*29.9*	*28.7*	5.9	5.8	*31.1*	*30.5*	8.6	9.0	*45.9*	*46.0*	19.7	20.3	18.4	18.5	5.3	10.7	6.9	6.9
																				(8)	(8)	(20)	(17)	(20)	(20)

[a] Medical department of Columbia University, New York City, Prof. Geo. S. Huntington's collection.
[b] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult males, whites, mesocephals (cephalic index 75.1 to 80.0).

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cœcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	cm.		cm.	cm.			cm.	cm.			cm.	cm.			cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.
1357x	(C. U.)	(?)	18.55	13.95	75.20	5.15	5.05	26.82	27.15	5.75	5.55	29.95	29.84	8.30	8.00	45.33	45.01	19.20	18.60	17.55	17.25	4.8	10.5	6.40	6.35
1.5, 1894-95	(C. U.)	Italy	18.70	14.10	75.40	5.05	(?)	27.59	(?)	4.90	5.00	26.77	(?)	8.35	8.50	45.63	(?)	18.30	(?)	(?)	(?)	5.0	10.2	6.50	6.60
1095x	(C. U.)	(?)	18.85	14.35	76.13	(?)	5.15	(?)	27.99	(?)	5.45	(?)	29.62	7.90	7.80	(?)	42.39	(?)	18.40	17.00	17.10	4.7	(?)	6.00	5.95
1105x	(C. U.)	(?)	18.70	14.30	76.47	5.30	4.55	28.07	24.93	5.70	5.70	30.16	31.25	7.90	8.00	41.79	43.84	18.90	18.25	17.65	17.15	5.0	10.0	6.40	6.30
10.4, 1895-96	(C. U.)	(?)	19.35	14.80	76.48	5.30	5.20	28.07	27.08	5.60	5.60	29.63	29.16	8.00	8.40	42.33	43.55	18.90	19.30	(?)	(?)	5.0	10.6	6.55	6.30
1079x	(C. U.)	(?)	18.60	14.35	77.15	4.90	5.05	26.56	26.65	5.70	5.80	30.89	30.65	7.85	8.10	42.55	42.74	18.45	18.95	17.15	17.20	4.5	10.0	6.35	6.35
623	(C. U.)	United States	18.40	14.20	77.17	(?)	4.95	(?)	26.76	5.60	5.50	(?)	29.75	7.70	8.05	(?)	43.51	(?)	18.50	16.65	17.10	5.0	10.7	6.40	6.30
344	(C. U.)	Ireland	18.20	14.10	77.47	5.50	5.50	29.49	28.28	5.40	5.80	28.96	29.82	7.75	8.15	41.56	41.90	18.65	19.45	17.05	(?)	5.4	10.7	6.20	6.25
1073x	(C. U.)	(?)	19.35	15.00	77.52	5.05	5.05	25.96	25.86	5.55	5.55	28.56	28.59	8.85	8.95	45.51	45.78	19.45	19.55	18.35	18.15	4.5	10.9	6.70	6.65
7.4, 1895-96	(C. U.)	United States	18.80	14.60	77.66	5.30	4.90	28.20	(?)	6.00	(?)	32.61	(?)	7.10	(?)	38.59	(?)	18.40	(?)	17.15	17.10	5.0	(?)	5.75	(?)
7.1, 1896-97	(C. U.)	Ireland	18.40	14.30	77.72	(?)	4.90	(?)	26.30	(?)	5.70	(?)	30.78	7.55	8.10	(?)	43.32	(?)	18.70	(?)	(?)	4.7	10.5	6.00	6.30
4.5, 1895-96	(C. U.)	(?)	18.50	14.40	77.84	5.20	5.15	28.57	27.54	4.80	4.85	26.37	25.93	8.20	8.70	45.05	46.52	18.20	18.70	17.05	17.35	4.7	9.8	6.40	6.85
1088x	(C. U.)	(?)	18.25	14.30	78.35	5.00	(?)	28.17	(?)	5.65	6.00	31.83	(?)	7.10	7.50	40.00	(?)	17.75	(?)	(?)	(?)	5.1	(?)	6.00	5.95
35.3, 1895-96	(C. U.)	(?)	19.00	14.90	78.42	5.50	5.30	29.57	28.19	5.60	5.40	30.11	28.72	7.50	8.10	40.32	43.09	18.60	18.80	16.95	17.00	4.6	10.5	5.90	6.20
799	(C. U.)	Italy	18.20	14.30	78.57	5.10	5.45	28.89	29.78	5.60	5.50	31.53	30.66	6.95	7.35	38.57	40.16	17.65	18.30	16.25	16.80	5.3	10.4	6.00	6.10
	(C. U.)	(?)	19.15	15.05	78.59	5.10	4.75	26.91	25.68	5.30	5.20	27.97	28.11	8.55	8.55	45.12	46.22	18.95	18.50	17.50	17.40	4.7	10.9	6.75	6.50
54.4, 1896-97	(C. U.)	(?)	18.80	14.80	78.72	4.95	(?)	25.73	(?)	5.70	(?)	31.96	(?)	7.20	7.80	40.34	(?)	17.85	(?)	(?)	(?)	4.8	9.6	6.00	6.00
1099x	(C. U.)	(?)	18.60	14.65	78.76	5.30	4.95	28.42	27.05	5.80	5.70	30.77	31.15	7.75	7.65	41.11	41.80	18.85	18.30	17.50	17.30	5.1	10.3	6.15	6.50
3.2, 1895-96	(C. U.)	(?)	17.80	14.10	79.21	5.00	(?)	27.93	(?)	5.40	(?)	30.17	(?)	7.50	7.50	41.89	(?)	17.90	(?)	16.40	(?)	5.0	10.7	6.05	5.90
803	(C. U.)	(?)	19.20	15.35	79.95	(?)	5.30	(?)	28.04	(?)	6.10	(?)	32.27	7.85	7.50	(?)	39.68	(?)	18.90	(?)	(?)	5.1	(?)	6.15	5.85
																				(12)	(12)	(20)	(16)	(20)	(19)
Average (11)[a]			18.7	14.5	77.5	5.22	5.09	27.9	27.10	5.53	5.51	29.5	29.3	7.96	8.18	42.6	43.6	18.71	18.78	17.23	17.27	4.9	10.1	6.23	6.27
Minimum (11)			18.2	13.9	75.2	4.9	4.5	25.9	24.9	4.8	4.8	26.4	25.9	6.9	7.3	39.4	40.2	17.6	18.2	16.2	16.8	4.5	9.6	5.7	5.8
Maximum (11)			19.3	15.0	78.8	5.5	5.5	29.5	29.8	5.8	5.8	31.7	31.2	8.8	8.9	45.5	46.5	19.4	19.5	18.3	18.4	5.3	10.9	6.7	6.8

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult males, whites, brachycephals (cephalic index 80.1 and above).

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.			Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.		Foramen cœcum to anterior border of pituitary fossa.			
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
26,2,1895–96	C. U.	(?)	18.00	14.40	80.00	(?)	4.55	(?)	25.27	4.50	4.80	(?)	27.35	8.20	8.20	(?)	46.72	(?)	17.55	(?)	(?)	4.2	(?)	6.80	6.80
383	C. U.	Italy	18.30	14.65	80.05	4.50	(?)	26.08	(?)	5.55	5.90	32.17	(?)	7.20	7.65	41.74	(?)	17.25	(?)	(?)	(?)	5.0	10.6	6.05	5.75
1086x	C. U.	(?)	19.60	15.75	80.35	4.80	(?)	25.60	(?)	5.50	5.60	29.33	(?)	8.15	8.45	45.07	(?)	18.75	(?)	17.80	17.55	5.0	10.5	6.50	6.50
	C. U.	(?)	18.80	15.15	80.58	5.05	5.05	27.23	26.16	5.80	5.70	31.27	29.56	7.70	8.55	41.51	44.30	18.55	19.30	17.20	17.45	5.1	10.6	6.30	6.60
1107x	C. U.	(?)	17.80	14.35	80.62	4.80	4.80	26.16	26.37	5.60	5.40	30.52	29.83	7.95	7.90	43.32	43.65	18.35	18.10	16.65	16.35	5.0	10.5	6.20	6.20
790	C. U.	Italy	17.30	14.20	82.08	5.00	(?)	27.93	(?)	5.60	(?)	31.28	(?)	7.30	7.50	40.78	(?)	17.90	(?)	(?)	(?)	4.2	(?)	5.70	5.95
1355	C. U.	(?)	18.20	14.95	82.14	5.35	5.25	29.72	28.92	5.40	5.40	30.00	29.75	7.25	7.50	40.28	41.32	18.00	18.15	16.65	16.70	5.1	10.7	6.20	6.45
878	C. U.	Italy	18.35	15.15	82.56	5.10	4.95	27.64	26.90	5.85	5.85	31.77	31.79	7.50	7.60	40.65	41.30	18.45	18.40	16.40	16.60	5.2	10.0	6.10	5.90
1080x	C. U.	(?)	18.25	15.10	82.74	4.90	4.60	26.13	24.73	5.65	5.60	30.15	30.11	8.20	8.40	43.73	45.16	18.75	18.60	17.20	17.10	4.7	11.3	6.30	6.25
1087	C. U.	(?)	18.00	15.00	83.33	(?)	5.45	(?)	29.46	5.30	5.30	(?)	28.65	7.50	7.75	(?)	41.89	(?)	18.50	(?)	(?)	(?)	(?)	6.50	6.25
1100x	C. U.	(?)	17.20	14.35	83.43	4.95	4.90	28.78	28.37	5.70	5.45	32.55	30.45	6.85	7.55	39.14	42.18	17.50	17.90	15.70	15.95	5.3	10.7	5.80	5.80
	C. U.	(?)	18.75	15.70	83.73	5.80	5.70	30.13	29.56	5.80	5.90	30.13	30.49	7.65	7.75	39.74	40.05	19.25	19.35	(?)	(?)	5.3	11.0	6.35	6.40
1351x	C. U.	(?)	18.15	15.30	84.30	4.70	4.80	25.96	26.09	5.70	5.70	31.49	30.98	7.70	7.90	42.55	42.93	18.10	18.40	16.80	16.90	4.8	11.1	6.40	6.40
1096x	C. U.	(?)	19.50	16.50	84.61	5.00	4.95	26.59	26.05	6.00	6.00	31.92	31.58	7.80	8.05	41.49	42.47	18.80	19.00	(?)	(?)	4.5	11.8	6.55	6.70
651	C. U.	Germany	17.80	15.30	85.96	4.85	(?)	26.14	(?)	5.70	(?)	30.75	(?)	8.00	(?)	43.12	(?)	18.55	(?)	(?)	(?)	4.7	(?)	6.45	(?)
	C. U.	(?)	17.10	15.00	86.84	4.75	4.45	26.91	25.78	5.60	5.50	31.75	31.35	7.30	7.65	41.36	43.46	17.65	17.60	15.80	15.75	4.6	10.6	6.30	6.35
2,5,1894–95	C. U.	(?)	17.90	15.45	86.31	4.80	4.85	26.82	26.82	5.80	5.60	31.85	30.85	7.60	7.70	41.76	42.42	18.20	18.15	(?)	(?)	4.3	10.4	6.10	6.10
726	C. U.	United States	18.60	16.10	86.56	(?)	4.70	(?)	25.61	(?)	5.75	(?)	31.35	7.80	7.90	(?)	43.05	(?)	18.35	(?)	(?)	4.8	11.4	6.55	6.60
107	C. U.	Germany	17.40	15.35	88.37	(?)	4.60	(?)	25.09	(?)	5.60	(?)	31.28	7.60	7.70	(?)	43.02	(?)	17.90	(?)	(?)	4.1	(?)	5.95	5.70
25,4,1896–97	C. U.	United States	18.70	16.80	89.84	5.20	(?)	27.81	(?)	6.30	(?)	33.87	(?)	7.40	8.00	39.15	(?)	18.90	(?)	17.10	(?)	5.0	11.5	6.40	6.85
																				(9)	(9)	(20)	(15)	(20)	19
Average (11)[a]			18.2	15.2	83.4	5.02	4.94	27.7	26.8	5.54	5.65	30.5	30.6	7.59	7.87	41.90	42.6	18.15	18.15	16.69	16.71	4.8	10.8	6.27	6.29
Minimum (11)			17.2	14.3	80.6	4.7	4.4	25.9	25.3	5.1	5.4	30.0	29.5	6.8	7.5	38.1	39.0	17.6	17.6	15.7	15.7	4.2	10.0	5.7	5.7
Maximum (11)			19.5	16.5	86.3	5.8	5.7	30.1	29.5	6.0	6.0	32.6	31.8	8.2	8.5	45.7	45.9	19.2	19.3	17.8	17.5	5.3	11.8	6.8	6.8

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult females, whites, dolichocephals.

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cæcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter anteroposterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter anteroposterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
703	(C. U.)	Italy	17.80	12.50	*70.22*	5.20	(?)	*29.72*	(?)	5.25	(5.45)	*30.00*	(?)	7.05	(7.70)	*40.29*	(?)	17.50	(?)	16.25	(?)	4.9	9.1	5.80	6.00
4.2, 1895–96	(C. U.)	(?)	17.85	12.90	*72.27*	4.60	4.40	*26.51*	*25.07*	5.35	5.20	*30.84*	*29.63*	7.40	7.95	*42.65*	*45.29*	17.35	17.55	16.35	16.70	4.6	9.8	5.95	6.15
1104x	(C. U.)	(?)	18.35	13.40	*73.02*	(?)	4.80	(?)	*27.12*	(?)	5.10	(?)	*28.81*	(7.40)	7.80	(?)	*44.07*	(?)	17.70	16.50	16.75	4.8	9.4	5.85	5.90
6.5, 1895–96	(C. U.)	(?)	16.75	12.30	*73.43*	5.00	4.90	*29.07*	*28.48*	5.00	4.80	*29.07*	*27.91*	7.20	7.50	*41.86*	*43.60*	17.20	17.20	15.20	15.50	4.8	9.3	5.60	5.70
1089x	(C. U.)	(?)	18.00	13.25	*73.61*	4.90	4.85	*28.32*	*27.56*	5.05	5.15	*29.19*	*29.26*	7.35	7.60	*42.48*	*43.78*	17.30	17.60	16.35	16.50	4.6	9.0	5.50	5.70
895	(C. U.)	(?)	18.60	13.70	*73.66*	5.00	5.00	*28.01*	*27.85*	5.05	5.00	*28.29*	*27.85*	7.80	7.95	*43.69*	*44.29*	17.85	17.95	17.10	17.10	4.6	(?)	6.15	5.95
X	(C. U.)	(?)	17.85	13.25	*74.23*	4.85	4.75	*28.03*	*26.61*	5.20	5.20	*30.05*	*29.13*	7.25	7.90	*41.92*	*44.26*	17.30	17.85	16.50	16.75	(?)	(?)	5.95	5.95
21.2, 1895–96	(C. U.)	(?)	17.50	13.05	*74.57*	(?)	4.90	(?)	*27.68*	(5.20)	5.30	(?)	*29.94*	(7.55)	7.50	(?)	*42.37*	(?)	17.70	16.45	16.65	4.8	(?)	6.10	5.75
1102x	(C. U.)	(?)	18.30	13.65	*74.59*	5.60	(?)	*30.11*	(?)	5.70	(?)	*30.65*	(?)	7.30	(7.15)	*39.25*	(?)	18.60	(?)	16.65	(?)	(?)	(?)	5.85	5.50
37.5, 1894–95	(C. U.)	Ireland	18.50	13.85	*74.86*	5.30	(?)	*29.61*	(?)	5.05	(4.95)	*28.21*	(?)	7.55	(7.80)	*42.18*	(?)	17.90	(?)	(?)	16.60	5.1	9.3	5.75	5.85
																						(8)	(6)	(10)	(10)
Average (5)[a]			17.8	13.1	*73.4*	4.87	4.78	*28.0*	*27.1*	5.13	5.07	*29.5*	*28.6*	7.40	7.78	*42.5*	*44.1*	17.40	17.63	16.3	16.5	4.8	9.3	5.85	5.84
Minimum (5)			16.7	12.3	*72.3*	4.6	4.4	*26.5*	*25.1*	5.0	4.8	*28.3*	*27.8*	7.2	7.5	*41.9*	*43.2*	17.2	17.2	15.2	15.5	4.6	9.0	5.5	5.5
Maximum (5)			18.6	13.7	*74.2*	5.0	5.0	*29.1*	*28.5*	5.3	5.2	*30.1*	*29.6*	7.8	7.9	*43.7*	*45.3*	17.8	17.9	17.1	17.1	5.1	9.8	6.1	6.1

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult females, whites, mesocephals.

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cœcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
15	(C. U.)	United States	18.20	13.70	*75.27*	(?)	5.25	(?)	*28.57*	5.10	5.10	(?)	*27.56*	7.90	8.15	(?)	*44.59*	(?)	18.5	(?)	(?)	1.5	10.0	6.25	6.20
21.4, 1898-99	(C. U.)	Ireland	18.35	13.85	*75.48*	5.20	5.05	*29.29*	*27.82*	5.40	5.40	*30.42*	*29.75*	7.15	7.70	*40.28*	*42.42*	17.75	18.15	16.40	16.80	5.1	10.1	5.90	5.90
41.1, 1895-96	(C. U.)	(?)	17.20	13.00	*75.58*	4.60	(?)	*25.37*	(?)	4.80	(?)	*28.57*	(?)	7.40	(?)	*44.05*	(?)	16.80	(?)	15.35	(?)	4.6	8.6	5.70	(?)
41.3, 1895-96	(C. U.)	Italy	18.00	13.90	*77.22*	4.90	(?)	*27.61*	(?)	5.30	(?)	*29.86*	(?)	7.55	7.90	*42.53*	(?)	17.75	(?)	16.30	(?)	4.0	9.6	6.30	6.40
1101 χ	(C. U.)	(?)	18.10	14.00	*77.35*	(?)	5.45	(?)	*29.46*	(?)	5.15	(?)	*27.84*	7.40	7.90	(?)	*42.70*	(?)	18.50	(?)	17.30	5.1	9.8	6.00	6.00
671	(C. U.)	United States	17.95	13.90	*77.43*	4.90	4.85	*27.68*	*27.09*	5.30	5.15	*29.94*	*28.72*	7.50	7.90	*42.37*	*44.14*	17.70	17.90	16.15	16.15	4.8	9.3	6.15	6.20
20.9, 1898-99	(C. U.)	do	18.20	14.10	*77.75*	4.75	4.75	*26.46*	*26.24*	4.90	4.95	*27.29*	*27.35*	8.30	8.40	*46.24*	*46.47*	17.95	18.10	17.15	16.95	4.8	9.9	6.70	6.70
1268	(C. U.)	(?)	17.90	14.00	*78.21*	5.05	4.85	*27.42*	*27.47*	5.00	4.90	*27.70*	*27.56*	8.00	7.90	*44.32*	*44.76*	18.05	17.65	16.65	16.40	(?)	(?)	6.20	6.15
796	(C. U.)	United States	17.00	13.60	*80.00*	5.20	5.10	*29.13*	*28.53*	5.75	5.35	*32.21*	*30.14*	6.90	7.30	*38.65*	*41.12*	17.85	17.75	16.05	16.05	4.9	9.7	5.70	5.75
	(C. U.)	(?)	17.25	13.80	*80.00*	5.20	5.05	*28.53*	*27.75*	5.25	5.50	*29.01*	*30.22*	7.65	7.65	*42.26*	*42.03*	18.10	18.20	16.20	16.35	(?)	(?)	6.20	5.80
Average (6)[a]			17.8	13.9	*78.1*	5.05	4.94	*28.2*	*27.5*	5.27	5.21	*29.4*	*29.0*	7.58	7.81	*42.4*	*43.5*	17.90	17.96	16.1	16.5	(8) 4.8	(8) 9.6	(9) 6.16	(9) 6.12
Minimum (6)			17.0	13.6	*75.5*	4.7	4.7	*26.5*	*26.2*	4.9	4.9	*25.3*	*27.3*	6.9	7.3	*38.6*	*41.1*	17.7	17.6	16.0	16.0	4.0	8.6	5.7	5.7
Maximum (6)			18.3	14.0	*80.0*	5.2	5.1	*29.3*	*28.7*	5.7	5.5	*32.2*	*30.2*	8.3	8.4	*46.2*	*46.4*	18.1	18.2	17.1	16.9	5.4	10.1	6.7	6.7

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossa (ventral). Adult females, whites, brachycephals.

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Skull.				Foramen cœcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.		Sum of the lengths of the fossæ.		Diameter antero-posterior maximum, ventrally.				Right.	Left.
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.				
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
1091 χ	(C. U.)	(?)	17.25	13.85	*80.29*	5.15	5.05	*29.17*	*28.61*	5.20	5.20	*29.46*	*29.46*	7.30	7.40	*41.36*	*41.92*	17.65	17.65	16.15	16.25	4.6	10.2	5.60	5.60
9.1, 1898–99	(C. U.)	(?)	17.10	14.00	*80.46*	4.65	(?)	*26.65*	(?)	5.40	(?)	*30.94*	(?)	7.40	(?)	*42.41*	(?)	17.45	(?)	16.25	(?)	4.4	(?)	6.10	(?)
10.3, 1896–97	(C. U.)	Ireland	18.00	11.50	*80.56*	4.60	4.60	*26.36*	*26.06*	5.10	5.00	*29.22*	*28.33*	7.75	8.05	*44.41*	*45.61*	17.45	17.65	15.85	16.30	4.7	9.2	6.35	6.25
182	(C. U.)	Germany	17.05	13.80	*80.94*	4.75	4.40	*28.02*	*25.88*	4.80	4.80	*28.32*	*28.24*	7.40	7.80	*43.65*	*40.00*	16.95	17.00	15.70	15.60	4.3	9.6	6.30	6.20
39.2, 1899–1900	(C. U.)	(?)	17.15	14.00	*81.63*	5.00	5.00	*28.01*	*28.17*	5.25	5.15	*29.41*	*29.01*	7.60	7.60	*42.58*	*42.82*	17.85	17.75	(?)	(?)	4.7	10.5	6.10	6.00
1360	(C. U.)	(?)	16.75	13.85	*82.69*	4.75	4.85	*26.98*	*27.71*	5.00	5.20	*28.41*	*29.71*	7.85	7.45	*44.61*	*42.58*	17.60	17.50	15.85	15.60	(?)	(?)	6.40	6.15
654	(C. U.)	France	17.40	14.10	*82.76*	5.10	5.10	*28.81*	*28.89*	5.50	5.50	*31.07*	*31.16*	7.10	7.05	*40.11*	*39.94*	17.70	17.65	(?)	(?)	4.8	10.6	5.65	5.85
1098 χ	(C. U.)	(?)	17.00	14.25	*83.82*	(?)	5.30	(?)	*29.20*	(?)	5.55	(?)	*30.58*	7.05	7.30	(?)	*40.22*	(?)	18.15	(?)	(?)	5.2	(?)	5.75	5.95
42.5, 1894–95	(C. U.)	(?)	17.20	15.35	*89.24*	(?)	4.45	(?)	*24.86*	(?)	5.55	(?)	*31.01*	6.80	7.90	(?)	*44.13*	(?)	17.90	(?)	(?)	(?)	(?)	5.50	6.05
483	(C. U.)	Ireland	17.80	(?)	(a)	(?)	4.70	(?)	*26.84*	(?)	5.20	(?)	*29.71*	(?)	7.60	(?)	*43.43*	(?)	17.50	(?)	(?)	4.9	(?)	(?)	5.80
Average (6)[b]			17.3	14.1	*81.5*	4.8	4.83	*27.9*	*27.5*	5.14	5.14	*29.3*	*29.3*	7.50	7.56	*42.8*	*43.2*	17.53	17.53	(4) 15.89	(4) 15.94	4.7	10.0	5.97	5.98
Minimum (6)			16.7	13.8	*80.2*	4.69	4.4	*26.4*	*25.9*	4.8	4.8	*28.3*	*28.2*	7.1	7.05	*40.1*	*39.9*	16.9	17.0	15.7	15.6	4.3	9.2	5.5	5.6
Maximum (6)			18.0	14.5	*82.8*	5.1	5.1	*29.2*	*28.9*	5.5	5.5	*31.1*	*31.2*	7.8	8.05	*44.6*	*45.6*	17.8	17.7	16.1	16.3	5.2	10.6	6.4	6.2

[a] Moderate brachycephals.

[b] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult males, Indians, dolichocephals.

No.	Collection.	Locality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cœcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.				Right.	Left.
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.				
			cm.	cm.		cm.	cm.			cm.	cm.			cm.	cm.			cm.	cm.	cm.	cm.	cm.	cm.	cm.	cm.
242.002	National Museum.	Santa Cruz Island, Cal.	18.50	13.25	71.62	4.20	4.50	23.56	25.49	5.70	5.50	31.57	31.16	8.15	7.65	45.17	43.35	18.05	17.65	16.75	16.30	4.7	9.6	6.50	6.10
242.006	do	do	18.80	13.70	72.87	4.70	4.75	25.53	25.53	5.50	5.20	29.65	27.73	8.35	8.80	45.02	44.94	18.50	18.75	17.15	17.25	4.3	10.1	6.70	6.70
241.969	do	do	18.90	13.80	73.02	5.60	5.25	29.71	27.92	5.50	5.30	29.15	28.19	7.75	8.25	41.12	43.80	18.85	18.80	17.60	17.70	5.0	10.2	6.40	6.90
241.961	do	do	17.90	13.15	73.46	4.65	4.50	26.12	25.42	5.10	5.00	29.31	28.25	7.65	8.20	45.96	46.33	17.40	17.70	15.95	16.30	4.6	9.6	6.30	6.30
242.361	do	Peru	18.40	13.60	73.91	4.60	4.45	25.37	24.86	5.15	5.20	28.35	29.05	8.40	8.25	46.29	46.09	18.15	17.90	17.05	17.15	4.3	(?)	6.50	6.20
242.362	do	do	17.70	13.10	74.01	4.85	4.80	27.85	27.17	5.30	5.10	29.76	28.81	7.25	7.80	41.65	44.02	17.40	17.70	16.05	16.35	4.5	(?)	6.10	5.90
241.945	do	Santa Cruz Island, Cal.	18.15	13.45	74.10	4.80	5.00	26.50	27.24	5.10	5.10	28.25	27.79	8.15	8.25	45.16	44.96	18.05	18.35	16.40	16.30	4.6	9.4	6.45	6.30
241.947	do	do	18.35	13.60	74.12	4.65	4.65	25.34	25.34	5.30	5.10	28.52	27.79	8.00	8.60	44.57	46.85	17.95	18.35	16.50	16.80	4.5	9.3	6.50	6.25
242.363	do	do	18.15	13.80	74.79	4.60	4.45	26.13	24.72	5.70	5.70	32.38	31.67	7.30	7.85	41.49	43.61	17.60	18.00	16.20	16.50	4.8	(?)	6.10	5.85
242.364	do	do	17.90	13.40	74.86	4.25	4.10	23.79	23.56	5.00	4.65	28.57	26.49	8.25	8.80	47.14	50.15	17.50	17.55	16.60	16.60	4.1	(?)	6.50	6.80
Average (10)[a]			18.3	13.5	73.7	4.69	4.64	26.1	25.7	5.33	5.18	29.7	28.7	7.92	8.24	44.1	45.7	17.94	18.07	16.6	16.7	4.5	9.7	6.40	6.33
Minimum (10)			17.7	13.1	71.6	4.2	4.1	23.3	23.4	5.0	4.6	28.2	26.5	7.2	7.6	41.1	43.3	17.4	17.5	15.9	16.3	4.1	9.4	6.1	5.8
Maximum (10)			18.9	13.8	74.9	5.6	5.2	29.7	27.9	5.7	5.7	32.4	31.7	8.4	8.8	47.1	50.1	18.8	18.8	17.6	17.7	5.0	10.2	6.7	6.9

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult males, Indians, brachycephals.

No.	Collection.	Locality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cœcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
242.365	National Museum	Peru	17.00	14.20	*83.53*	4.70	4.45	*27.65*	*26.25*	5.20	5.20	*30.59*	*30.68*	7.10	7.30	*41.76*	*43.07*	17.00	16.95	15.60	15.50	4.2	.....	5.90	5.80
242.366	....do	....do	16.30	13.80	*84.66*	4.55	4.55	*26.09*	*26.84*	5.40	5.40	*31.67*	*31.86*	7.10	7.00	*42.24*	*41.30*	17.05	16.95	15.00	15.00	4.2	.....	5.75	5.70
242.367	....do	....do	17.10	14.80	*85.06*	4.65	4.60	*25.54*	*25.27*	5.60	5.55	*30.76*	*30.49*	7.95	8.05	*43.70*	*44.24*	18.20	18.20	16.05	16.25	4.4	.....	6.65	6.55
242.368	....do	....do	17.40	14.80	*85.06*	4.70	4.60	*26.48*	*26.82*	5.45	5.00	*30.70*	*29.15*	7.60	7.55	*42.82*	*44.03*	17.75	17.15	15.80	15.80	4.5	11.1	6.20	6.35
242.369	....do	....do	17.40	14.80	*85.06*	4.55	4.65	*25.71*	*26.34*	5.30	5.30	*29.94*	*30.03*	7.85	7.70	*44.35*	*43.63*	17.70	17.65	16.00	16.10	4.4	.....	6.35	6.15
242.370	....do	....do	17.40	14.80	*85.06*	4.10	4.55	*25.07*	*27.00*	5.70	5.05	*32.47*	*29.96*	7.45	7.25	*42.96*	*43.03*	17.55	16.85	15.80	15.85	4.6	10.4	5.80	5.90
242.371	....do	....do	16.80	14.60	*86.90*	4.65	4.65	*27.76*	*27.59*	5.00	4.90	*29.85*	*29.08*	7.10	7.30	*42.39*	*43.03*	16.75	16.85	15.00	15.30	4.5	.....	5.50	5.40
242.372	....do	....do	16.80	14.80	*88.10*	4.35	4.10	*25.59*	*24.62*	5.30	5.30	*31.17*	*31.83*	7.35	7.25	*43.24*	*43.55*	17.00	16.65	15.10	15.20	4.4	10.9	5.85	5.45
242.373	....do	....do	16.30	14.40	*88.34*	4.65	4.55	*28.01*	*26.76*	5.50	5.35	*33.13*	*31.47*	6.65	7.10	*38.86*	*41.77*	16.80	17.30	14.10	14.50	4.4	.....	5.40	5.80
242.374	....do	....do	16.60	15.20	*91.57*	4.50	4.45	*26.47*	*26.18*	5.15	4.90	*30.29*	*28.82*	7.35	7.65	*43.24*	*45.00*	17.00	17.00	14.90	14.90	4.4	.....	5.90	6.00
	Average (10)[a]		16.9	14.6	*86.33*	4.57	4.52	*26.44*	*26.37*	5.36	5.19	*31.06*	*30.34*	7.35	7.41	*42.51*	*43.26*	17.28	17.12	15.33	15.44	4.4	10.8	5.93	5.91
	Minimum (10)		16.3	13.8	*83.53*	4.35	4.10	*25.07*	*24.62*	5.00	4.90	*29.85*	*29.08*	6.65	7.00	*38.86*	*41.30*	16.75	16.65	14.10	14.50	4.2	10.4	5.40	5.40
	Maximum (10)		17.4	15.2	*91.57*	4.70	4.65	*28.01*	*27.59*	5.70	5.55	*33.13*	*31.86*	7.95	8.05	*44.35*	*45.00*	18.20	18.20	16.05	16.25	4.6	11.1	6.65	6.55

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult males, negroes (African and American), dolicho- to mesocephals.

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cœcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
980	(A. M. M.) [a]	American negro.	19.90	14.30	71.86	5.20	5.20	27.51	27.22	6.00	5.95	31.74	31.15	7.70	7.95	40.74	41.62	18.90	19.10	17.30	17.40	5.3	10.3	6.35	6.50
23.4.1895-96	(C. U.)	do	18.40	13.40	72.83	(?)	4.70	(?)	25.56	5.00	4.70	(?)	27.56	7.55	7.65	(?)	44.87	(?)	17.05	(?)	(?)	4.4	8.9	5.65	5.80
1356	(C. U.)	American negro or mulatto.	18.20	13.30	73.08	4.90	5.00	26.77	26.95	5.30	5.20	28.96	28.76	8.10	8.35	44.26	45.01	18.30	18.55	16.80	16.80	5.1	10.6	6.20	6.40
2331	(A. M. M.)	do	19.00	13.90	73.16	5.05	5.05	28.06	27.29	5.20	5.20	28.89	28.11	7.75	8.25	43.06	44.39	18.00	18.50	16.95	17.20	4.8	10.3	6.05	6.20
3023	(A. M. M.)	Africanne gro.	18.30	13.40	73.22	5.05	5.00	28.06	27.70	5.00	4.80	27.78	26.59	7.95	8.25	44.17	45.77	18.00	18.05	16.20	16.40	4.6	10.2	6.35	6.45
930	(C. U.)	American negro.	18.20	13.40	73.63	5.05	4.90	30.24	27.47	5.40	5.40	32.53	30.17	6.25	7.60	36.42	42.46	16.70	17.90	16.00	16.85	5.0	(?)	6.20	7.30
979	(A. M. M.)	do	19.00	14.00	73.68	5.20	5.20	28.80	27.81	5.40	5.25	29.35	28.07	7.70	8.25	41.85	44.12	18.40	18.70	17.20	17.40	4.9	10.5	6.20	6.30
12.4.1896-97	(C. U.)	do	19.10	14.20	74.35	5.45	5.15	28.91	26.62	5.50	5.90	29.18	30.49	7.90	8.30	41.91	43.89	18.85	19.35	17.85	18.05	5.0	9.6	6.50	6.50
975	(A. M. M.)	do	18.65	14.10	75.60	5.00	5.00	27.17	27.78	5.70	5.50	30.98	30.56	7.70	7.50	41.85	41.67	18.40	18.00	16.40	16.30	4.8	10.6	6.45	6.20
3086	(A. M. M.)	Africanne gro.	17.60	13.40	75.71	4.90	5.00	27.85	28.47	5.15	5.00	28.77	27.47	7.85	8.20	45.85	45.05	17.90	18.20	16.30	16.30	4.8	10.2	6.60	6.90
	(C. U.)	American negro or mulatto.	18.45	14.00	75.88	5.10	5.10	26.56	27.13	5.60	5.80	29.16	30.85	8.50	7.90	44.27	42.02	19.20	18.80	17.20	17.20	4.9	10.1	6.80	6.75
	(C. U.)	do	18.60	14.15	76.07	4.90	4.70	26.13	25.07	5.45	5.45	29.07	29.07	8.40	8.60	44.80	45.87	18.75	18.75	(?)	(?)	4.5	10.9	7.10	6.90
3022	(A. M. M.)	do	17.90	13.70	76.54	5.50	5.15	30.89	28.61	4.85	5.00	27.24	27.70	7.45	7.85	41.85	43.61	17.80	18.00	16.35	16.35	4.7	10.2	5.70	6.00
981	(A. M. M.)	do	18.40	14.10	76.63	5.15	4.90	30.70	27.61	5.00	5.00	28.17	28.17	7.30	7.85	41.13	44.53	17.75	17.75	16.25	16.35	4.5	10.2	6.10	6.00
222.126	(N. M.)	do	18.40	14.30	78.14	4.90	4.70	27.61	26.53	5.20	5.50	29.29	31.16	7.65	7.45	43.09	42.31	17.75	17.65	16.00	15.85	4.1	9.7	6.10	5.75
Average (14) [b]			18.6	13.9	74.8	5.12	5.00	28.2	27.2	5.34	5.35	29.3	29.1	7.73	8.02	42.5	43.7	18.19	18.38	(13) 16.68	(13) 16.82	(15) 4.8	(14) 10.2	(15) 6.29	(15) 6.39
Minimum 14)			17.6	13.3	71.9	4.9	4.7	26.1	25.1	4.8	4.8	27.2	26.6	6.2	7.4	37.4	41.6	16.7	17.0	16.0	15.8	4.1	8.9	5.6	5.7
Maximum (14)			19.9	14.3	78.1	5.5	5.2	30.9	28.6	6.0	5.9	32.3	31.2	8.5	8.6	44.8	45.9	19.2	19.3	17.8	18.0	5.1	10.9	7.1	7.3

[a] Army Medical Museum; Transferred since to National Museum.

[b] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Adult females, negroes (African and American), dolicho- to mesocephals.

No.	Collection.	Nationality.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cæcum to anterior border of pituitary fossa.	Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
			Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
						Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
			cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
1093x	(C. U.)	American negro.	18.40	13.20	*71.74*	(?)	4.85	(?)	*27.63*	5.30	5.50	(?)	*31.34*	7.30	7.20	(?)	*41.02*	(?)	17.55	16.40	16.40	4.4	10.1	5.50	5.30
27.5, 1894-95	(C. U.)	do	18.10	13.15	*73.10*	(?)	4.90	(?)	*27.17*	4.90	5.10	(?)	*28.25*	7.90	8.05	(?)	*44.39*	(?)	18.05	16.20	16.20	4.5	9.8	6.20	6.20
1802	(A.M.M.)	do	17.75	13.60	*76.34*	5.10	4.65	*30.00*	*27.27*	5.20	5.00	*30.59*	*29.42*	7.20	7.10	*42.35*	*43.40*	17.50	17.05	16.05	15.90	4.3	9.2	5.75	5.80
1109x	(C. U.)	do	17.70	13.20	*74.58*	4.90	4.75	*27.75*	*26.68*	5.35	5.35	*29.95*	*30.05*	7.60	7.70	*42.55*	*43.56*	17.85	17.80	15.95	15.75	4.6	9.5	6.15	6.00
1353x	(C. U.)	do	17.30	13.10	*75.72*	5.00	4.75	*29.41*	*27.69*	4.85	5.00	*28.53*	*29.15*	7.15	7.40	*42.06*	*43.17*	17.00	17.15	15.80	15.80	5.1	10.6	6.20	6.40
652	(C. U.)	do	17.95	13.65	*76.05*	5.20	(?)	*29.05*	(?)	4.70	(?)	*26.26*	(?)	8.00	7.85	*44.69*	(?)	17.90	(?)	16.15	16.35	4.8	9.6	6.20	5.90
16, 2, 1898-99	(C. U.)	do	17.00	13.60	*80.47*	4.95	(?)	*28.75*	(?)	4.90	4.90	*28.16*	(?)	7.55	7.80	*45.39*	(?)	17.40	(?)	15.60	(?)	4.5	9.5	6.20	6.20
1319x	(C. U.)	do	17.85	13.90	*77.87*	5.15	5.15	*28.85*	*28.64*	4.70	4.80	*26.47*	*26.67*	8.10	8.05	*45.74*	*44.72*	17.95	18.00	(?)	(?)	4.5	9.3	6.15	6.20
1348x	(C. U.)	do	17.90	14.00	*78.21*	5.40	5.30	*31.12*	*29.97*	4.80	4.65	*27.65*	*26.27*	7.15	7.75	*41.21*	*43.79*	17.35	17.70	16.65	16.65	4.8	10.0	5.60	5.80
745	(C. U.)	do	17.00	13.45	*79.11*	(?)	5.10	(?)	*30.35*	5.10	5.00	(?)	*29.76*	7.00	6.70	(?)	*39.88*	(?)	16.80	(?)	(?)	4.6	9.7	5.75	5.65
																				(8)	(7)	(10)	(10)	(10)	(10)
Average (5) [a]			17.7	13.4	*75.9*	5.11	4.92	*29.1*	*28.0*	4.98	4.96	*28.4*	*28.3*	7.44	7.66	*42.4*	*43.7*	17.53	17.54	16.1	16.1	4.6	9.7	6.0	5.94
Minimum (5)			17.3	13.0	*73.2*	4.9	4.6	*27.2*	*26.7*	4.7	4.6	*24.8*	*26.3*	7.1	7.4	*41.2*	*43.1*	17.0	17.0	15.6	15.7	4.3	9.2	5.5	5.3
Maximum (5)			17.9	13.9	*78.2*	5.4	5.3	*31.1*	*29.9*	5.3	5.3	*30.6*	*30.0*	8.1	8.0	*42.7*	*44.7*	17.9	18.0	16.6	16.6	5.1	10.6	6.4	6.4

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Fetuses and children, white, brachycephals.

No.	Collection.	Sex.	Length of body.		Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
								Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.				
			Breech-vertex.	Extended.	Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.				
			cm.	*cm.*	*cm.*	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
224.843	National Museum.	Male	5.2	6.7	2.10	1.70	*80.95*	0.60	0.60	*33.33*	*33.33*	0.50	0.50	*27.78*	*27.78*	0.70	0.70	*38.89*	*38.89*	1.80	1.80	1.65	1.65	(?)	(?)	(?)
224.842	do	do	8.3	11.7	3.00	2.50	*83.33*	1.05	1.05	*31.82*	*33.33*	.95	.90	*28.79*	*28.57*	1.30	1.20	*39.39*	*38.10*	3.30	3.15	2.70	2.60	(?)	1.10	1.10
220.183	do	do	19.9	29.4	6.60	5.50	*83.33*	2.10	2.10	*29.57*	*29.57*	2.60	2.10	*28.17*	*29.57*	3.00	2.90	*42.26*	*40.86*	7.10	7.10	6.50	6.50	4.6	2.40	2.35
224.836	do	do	21.0	32.5	7.75	6.05	*78.06*	2.40	2.40	*28.74*	*29.09*	2.25	2.25	*26.94*	*27.27*	3.70	3.60	*44.32*	*43.64*	8.35	8.25	7.45	7.35	4.9	2.85	2.80
220.180	do	do	23.5	34.4	7.60	6.55	*86.18*	2.45	2.35	*29.88*	*28.48*	2.35	2.40	*28.66*	*29.09*	3.40	3.50	*41.46*	*42.43*	8.20	8.25	7.40	7.40	5.1	2.45	2.55
224.886	do	do	26.5	38.9	8.80	7.70	*87.50*	2.80	2.75	*29.78*	*29.35*	2.80	2.80	*29.78*	*29.78*	3.80	3.85	*40.44*	*40.97*	9.40	9.40	8.50	8.60	6.6	3.10	3.10
218.036	do	do	(?)	(?)	10.80	9.50	*87.96*	3.10	3.10	*27.43*	*27.43*	3.10	3.10	*27.43*	*27.43*	5.10	5.10	*45.13*	*45.13*	11.30	11.30	10.50	10.50	(?)	5.10	5.10
1106x	(C. U.)	do	(a)	(a)	16.70	14.30	*85.63*	5.25	5.05	*29.83*	*28.69*	5.40	5.50	*30.68*	*31.25*	6.95	7.05	*39.49*	*40.06*	17.60	17.60	(?)	(?)	(?)	5.65	5.90
224.860	National Museum.	Female	21.0	(?)	7.55	6.35	*84.11*	2.50	2.45	*33.56*	*33.11*	2.30	2.20	*30.87*	*29.73*	2.65	2.75	*35.57*	*37.16*	7.45	7.40	6.40	6.40	4.7	2.30	2.30
220.182	do	do	25.1	36.3	8.45	6.80	*80.47*	2.60	2.60	*29.71*	*29.58*	2.75	2.65	*31.43*	*29.94*	3.40	3.60	*38.86*	*40.68*	8.75	8.85	7.85	7.95	5.6	2.40	2.55
																						(9)	(9)	(6)	(9)	(9)
Average (10) *b*					7.93	6.69	*84.4*	2.48	2.44	*29.8*	*29.4*	2.44	2.44	*29.3*	*29.3*	3.40	3.42	*40.9*	*41.3*	8.32	8.31	6.55	6.55	5.2	3.04	3.08
Minimum (10)					2.1	1.7	*78.1*	.6	.6	*28.4*	*28.4*	.5	.5	*26.9*	*25.3*	.7	.7	*35.6*	*35.2*	1.8	1.8	1.6	1.6	4.6	1.1	1.1
Maximum (10)					16.7	14.3	*87.9*	5.2	5.0	*33.6*	*33.3*	5.1	5.5	*31.4*	*31.2*	6.9	7.0	*45.1*	*45.1*	17.6	17.6	10.5	10.5	6.6	5.6	5.9

a Child about 6 years old.

b Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Fetuses and children, colored, brachycephals.

No.	Collection.	Sex.	Length of body.		Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
								Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.				
			Breech-vertex.	Extended.	Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.						
			cm.	*cm.*	*cm.*	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
224.837	National Museum.	Male	17.6	27.0	6.25	5.10	*81.60*	2.15	2.10	*33.33*	*32.81*	1.95	1.95	*30.23*	*30.47*	2.35	2.35	*36.44*	*36.72*	6.45	6.40	5.75	5.75	4.2	1.70	1.70
224.851	do	do	23.7	(?)	10.20	8.40	*82.35*	3.35	3.25	*31.16*	*30.66*	2.90	2.90	*26.98*	*27.36*	4.50	4.45	*41.86*	*41.98*	10.75	10.60	9.90	9.90	6.3	3.40	3.30
224.855	do	do	30.8	45.0	10.20	8.50	*83.33*	3.20	3.20	*29.49*	*29.49*	2.90	2.90	*26.73*	*26.73*	4.75	4.75	*43.78*	*43.78*	10.85	10.85	9.60	9.60	7.1	3.60	3.50
224.854	do	do	35.9	52.7	10.50	8.90	*84.76*	3.50	3.30	*29.91*	*28.45*	3.10	3.00	*26.49*	*25.86*	5.10	5.30	*43.60*	*45.69*	11.70	11.60	10.50	10.40	7.1	3.75	3.75
224.857	do	do	36.4	50.6	10.90	9.00	*82.57*	3.00	3.00	*26.20*	*26.20*	3.25	3.35	*28.38*	*29.26*	5.20	5.10	*45.42*	*44.54*	11.45	11.45	10.50	10.40	7.0	4.25	4.15
224.853	do	Female	20.3	(?)	7.00	5.90	*84.29*	2.50	2.50	*33.33*	*32.47*	2.10	2.10	*28.00*	*27.27*	2.90	3.10	*38.67*	*40.26*	7.50	7.70	6.90	7.00	5.1	2.20	2.30
220.179	do	do	21.7	32.9	7.90	6.45	*81.65*	2.25	2.25	*26.78*	*26.78*	2.25	2.25	*26.78*	*26.78*	3.90	3.90	*46.44*	*46.44*	8.40	8.40	7.40	7.40	5.0	3.20	3.20
224.856	do	do	25.4	39.7	9.30	7.70	*82.80*	2.90	2.85	*29.14*	*29.23*	2.75	2.80	*27.64*	*28.72*	4.30	4.10	*43.22*	*42.05*	9.95	9.75	8.80	8.70	6.0	3.40	3.30
224.885	do	do	28.1	41.3	8.80	7.20	*82.95*	2.60	2.60	*29.38*	*29.21*	2.30	2.30	*25.99*	*25.84*	3.95	4.00	*44.63*	*44.95*	8.85	8.90	8.70	8.70	6.6	3.10	3.10
224.874	do	do	31.7	46.1	11.10	9.00	*81.08*	3.30	3.20	*28.69*	*28.07*	3.10	3.10	*26.96*	*27.19*	5.10	5.10	*44.35*	*44.74*	11.50	11.40	10.60	10.60	7.1	3.75	3.80
Average (10) [a]					9.21	7.62	*82.7*	2.87	2.82	*29.5*	*29.1*	2.60	2.66	*27.3*	*27.5*	4.20	4.21	*43.2*	*43.4*	.....	9.70	8.86	8.84	6.1	3.23	3.21
Minimum (10)					6.62	5.01	*81.1*	2.1	2.1	*26.2*	*26.2*	1.9	1.9	*26.0*	*25.8*	2.3	2.3	*36.4*	*36.7*	9.74	6.4	5.7	5.7	4.2	1.7	1.7
Maximum (10)					11.1	9.0	*84.7*	3.5	3.3	*33.3*	*32.8*	3.3	3.3	*30.2*	*30.5*	5.2	5.3	*45.4*	*46.4*	6.4 11.7	11.6	10.6	10.6	7.1	4.2	4.1

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Fetuses, colored; dolicho- to mesocephals.

No.	Collection.	Sex.	Length of body		Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.					Skull.			Length of posterior fossa, cerebellar portion.	
								Length.		Index.		Length.		Index.		Length.		Index.		Sum of the lengths of the fossæ.		Diameter antero-posterior maximum, ventrally.		Foramen cæcum to anterior border of pituitary fossa.		
			Breech vertex.	Extended	Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.							
			cm.	cm.	cm.	cm.		cm.	cm.			cm.	cm.			cm.	cm.			cm.	cm.	cm.	cm.	cm.	cm.	cm.
224,882.	National Museum.	Males.	17.4	25.5	6.40	5.00	78.13	2.05	2.00	30.59	30.08	2.05	2.05	31.58	32.68	2.60	2.60	38.82	39.09	6.70	6.65	5.80	5.80	4.4	1.95	1.95
224,877.	do	do	20.8	29.5	7.20	5.70	79.17	2.20	2.15	28.95	28.10	2.40	2.50	31.58	32.68	3.00	3.00	39.47	39.22	7.60	7.65	7.00	7.00	4.7	2.30	2.30
224,835.	do	do	23.1	34.5	8.25	6.20	75.15	2.50	2.50	29.41	30.12	2.50	2.40	29.41	28.92	3.50	3.40	41.18	40.96	8.50	8.30	7.60	7.60	5.3	2.60	2.55
224,864.	do	do	26.1	38.6	8.80	7.00	79.55	2.70	2.70	30.00	30.34	2.50	2.40	27.78	26.96	3.80	3.80	42.22	42.70	9.00	8.90	8.30	8.20	5.3	2.80	2.80
224,873.	do	do	27.5	41.6	10.40	7.90	75.96	3.40	3.30	32.67	30.84	2.90	2.90	27.36	27.10	4.30	4.50	40.57	42.06	10.60	10.70	9.70	9.80	6.2	3.00	3.20
224,872.	do	do	27.7	(?)	9.00	6.90	76.67	2.70	2.70	30.00	29.51	2.50	2.50	27.78	28.32	3.80	3.95	42.22	43.17	9.00	9.15	8.20	8.30	5.5	3.00	3.15
224,858.	do	do	30.7	(?)	10.10	8.00	79.21	3.10	3.25	29.58	30.09	2.85	2.85	27.01	26.39	4.60	4.70	43.61	43.52	10.55	10.80	9.80	9.70	6.2	3.20	3.20
224,863.	do	do	31.5	(?)	12.10	9.10	75.21	3.40	3.30	28.09	27.73	3.20	3.10	26.44	26.05	5.50	5.50	45.47	46.22	12.10	11.90	11.20	11.20	7.6	4.20	4.10
224,865.	do	do	32.5	48.5	12.70	9.40	74.02	4.05	3.95	30.59	30.04	3.30	3.10	24.90	24.57	5.90	6.10	44.54	46.39	13.25	13.15	12.30	12.20	8.3	4.35	4.50
224,862.	do	do	36.6	(?)	12.70	9.50	74.80	4.20	4.20	31.82	31.11	3.20	3.10	24.24	22.96	5.80	6.20	43.94	45.93	13.20	13.50	12.10	12.30	7.6	4.40	4.80
Average (10)[a]					9.76	7.47	76.5	3.03	3.00	30.1	29.84	2.74	2.69	27.3	26.7	4.28	4.37	42.6	43.5	10.05	10.07	9.19	9.21	6.1	3.18	3.25
Minimum (10)					6.4	5.0	74.0	2.0	2.0	28.1	27.7	2.0	2.0	24.2	22.9	2.6	2.6	38.8	39.1	6.7	6.6	5.8	5.8	4.4	1.9	1.9
Maximum (10)					12.7	9.5	79.5	4.2	4.2	32.1	31.1	3.3	3.1	31.6	32.7	5.9	6.2	45.5	46.4	13.2	13.5	12.3	12.3	8.3	4.4	4.8

[a] Number of skulls in which all the fossæ could be measured.

Cranial fossæ (ventral). Fetuses, colored, dolicho- to mesocephals—Continued.

No.	Collection.	Sex.	Length of body.		Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Foramen cæcum to anterior border of pituitary fossa.	Length of posterior fossa, cerebellar portion.	
								Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.					
			Breech vertex.	Extended.	Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.		Right.	Left.
			cm.	*cm.*	*cm.*	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
224,883.	National Museum.	Females..	15.9	23.4	5.05	3.55	*70.30*	1.70	1.60	*33.07*	*31.68*	1.55	1.55	*30.09*	*30.69*	1.90	1.90	*36.90*	*37.63*	5.15	5.05	4.70	4.70	3.1	1.65	1.65
224,878.	.....do	.....do	21.8	32.5	7.40	5.40	*72.97*	2.20	2.20	*29.33*	*29.33*	2.10	2.10	*28.00*	*28.00*	3.20	3.20	*42.67*	*42.67*	7.50	7.50	7.10	7.10	4.8	2.65	2.65
224,879.	.....do	.....do	26.1	29.6	9.40	7.30	*77.66*	2.65	2.45	*27.75*	*26.20*	2.70	2.70	*28.27*	*28.88*	4.20	4.20	*43.98*	*44.92*	9.55	9.35	8.90	8.90	6.1	3.05	3.10
224,866.	.....do	.....do	27.3	(a)	10.40	7.70	*74.04*	3.20	3.10	*31.22*	*31.00*	2.80	2.65	*27.31*	*26.50*	4.25	4.25	*41.47*	*42.50*	10.25	10.00	9.55	9.15	6.1	3.00	2.95
224,867.	.....do	.....do	28.7	45.9	11.00	8.60	*78.18*	3.30	3.20	*28.95*	*28.69*	3.00	2.85	*26.31*	*25.56*	5.10	5.10	*44.74*	*45.55*	11.40	11.15	10.50	10.30	7.0	3.90	3.80
224,870.	.....do	.....do	30.9	45.3	10.00	7.90	*79.00*	2.90	2.90	*28.15*	*28.43*	2.90	2.80	*28.15*	*27.45*	4.50	4.50	*43.70*	*44.12*	10.30	10.20	9.60	9.60	6.4	3.30	3.40
224,876.	.....do	.....do	31.1	44.9	10.20	7.60	*74.51*	3.10	3.10	*30.69*	*30.69*	2.60	2.60	*25.74*	*25.74*	4.40	4.40	*43.57*	*43.57*	10.10	10.10	9.40	9.40	6.2	3.10	3.40
224,875.	.....do	.....do	33.7	48.5	10.10	8.80	*79.28*	3.30	3.30	*28.94*	*28.69*	3.10	3.10	*27.19*	*26.96*	5.00	5.10	*44.84*	*44.35*	11.40	11.50	10.60	10.60	7.3	3.75	3.85
224,861.	.....do	.....do	34.7	53.0	11.80	9.00	*76.27*	4.20	4.00	*32.18*	*30.77*	3.35	3.25	*25.67*	*25.00*	5.50	5.75	*42.15*	*44.33*	13.05	13.00	11.40	11.50	7.4	4.40	4.50
224,871.	.....do	.....do	36.8	52.9	10.90	8.60	*78.90*	3.05	3.05	*27.23*	*27.75*	2.95	2.75	*26.34*	*25.00*	5.20	5.20	*46.43*	*47.27*	11.20	11.00	10.30	10.30	7.2	3.10	3.30
Average (10)a					9.6	7.4	*77.3*	2.96	2.89	*29.6*	*29.2*	2.70	2.63	*27.1*	*26.7*	4.32	4.36	*43.3*	*44.1*	9.99	9.88	9.20	9.18	6.2	3.22	3.26
Minimum (10)					5.0	3.5	*70.3*	1.7	1.6	*27.2*	*26.2*	1.5	1.5	*25.7*	*25.0*	1.9	1.9	*36.9*	*37.6*	5.1	5.0	4.7	4.7	3.1	1.6	1.6
Maximum (10)					11.8	9.6	*79.3*	4.2	4.0	*33.0*	*31.7*	3.3	3.2	*30.1*	*30.7*	5.5	5.7	*46.4*	*47.3*	13.0	13.0	11.4	11.5	7.4	4.4	4.5

a Number of skulls in which all the fossæ could be measured.

No.	Species.	Collection	Age.	Sex.	Skull.			Anterior fossa.				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.			Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
					Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.		Greatest breadth of skull ventrally.			
								Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.			Right.	Left.
					cm.	*cm.*		*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*			*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
84.655.	Chimpanzee.	National Museum.	Adult.	Female.	12.10	10.40	*85.95*	3.95	3.80	*31.10*	*30.16*	4.00	3.90	*31.49*	*30.95*	4.75	4.90	*37.41*	*38.89*	12.70	12.60	11.20	11.10	9.5	8.30	4.20	4.20
4.705½	....do.....	.....do.....	...do....	...do....	11.75	9.55	*81.28*	4.00	3.85	*31.13*	*30.20*	3.80	3.70	*29.65*	*29.80*	5.05	5.20	*39.22*	*40.00*	12.85	12.75	10.95	10.95	(?)	(?)	4.35	4.40
x	Gorilla....	C.U.....	...do..	Male ..	(?)	(?)	(?)	3.90	3.85	*27.66*	*27.10*	4.40	4.20	*31.20*	*29.58*	5.80	6.15	*41.14*	*43.31*	14.10	14.20	(?)	(?)	(?)	(?)	4.20	4.35
142.189.	Orang....	National Museum.	...do..	...do....	12.40	9.40	.....	3.65	3.50	*28.18*	*27.34*	4.00	3.75	*30.88*	*29.29*	5.30	5.55	*40.94*	*43.37*	12.95	12.80	11.10	11.10	9.1	7.65	4.30	4.50
142.198.	....do.....	.....do....	...do..	...do....	12.60	10.00	.....	3.80	3.80	*29.12*	*29.34*	3.80	3.90	*29.12*	*30.12*	5.45	5.25	*41.76*	*40.54*	13.05	12.95	10.95	10.85	9.0	7.65	4.20	3.95
142.199.	....do.....	.....do....	...do..	...do....	12.10	9.80	.....	4.00	4.00	*30.30*	*29.85*	3.70	3.60	*28.03*	*26.86*	5.50	5.80	*41.67*	*43.29*	13.20	13.40	10.90	10.90	9.5	8.00	4.20	4.20
142.169.	....do.....	.....do....	...do..	Female	11.30	9.30	.....	3.60	3.40	*31.17*	*29.31*	3.55	3.50	*30.73*	*30.17*	4.40	4.70	*38.10*	*40.52*	11.55	11.60	9.90	10.10	8.5	7.15	3.95	4.30
142.186.	....do.....	.....do....	...do..	...do....	11.70	9.60	.....	3.60	3.50	*29.65*	*28.84*	3.80	3.80	*31.27*	*31.77*	4.75	4.85	*39.10*	*39.93*	12.15	12.15	10.25	10.25	9.2	7.50	3.90	4.10
142.182.	....do.....	.....do....	...do..	...do....	11.50	9.80	.....	3.30	3.35	*27.97*	*28.63*	3.60	3.55	*30.51*	*30.34*	4.90	4.80	*41.52*	*41.03*	11.80	11.70	10.00	10.05	8.9	7.10	4.00	3.80
115.501.	Gibbon....	.....do.....	...do..	Male ...	8.00	6.30	*78.75*	2.85	2.80	*34.13*	*32.94*	2.55	2.55	*30.54*	*30.00*	2.95	3.15	*35.33*	*37.06*	8.35	8.50	7.65	7.65	5.8	4.95	2.40	2.40
101.138.	....do.....	.....do....	...do..	...do....	7.40	6.30	*85.14*	2.60	2.65	*34.32*	*34.32*	2.50	2.45	*30.12*	*29.59*	3.20	3.20	*38.56*	*38.56*	8.30	8.30	7.10	7.20	6.2	5.20	2.60	2.60
142.711.	....do.....	.....do....	...do..	Female.	7.70	6.50	*84.47*	2.80	2.85	*33.73*	*34.54*	2.50	2.40	*30.12*	*29.09*	3.00	3.00	*36.15*	*36.37*	8.30	8.25	7.40	7.40	6.25	5.30	2.40	2.50
115.502.	....do.....	.....do....	...do..	...do....	7.10	5.90	*83.10*	2.65	2.65	*33.54*	*33.54*	2.20	2.20	*27.85*	*27.85*	3.05	3.05	*38.61*	*38.61*	7.90	7.90	6.90	6.90	5.6	4.50	2.40	2.40

Cranial fossæ (ventral). Monkeys and other mammals.

No.	Species.	Collection.	Age.	Sex.	Skull.			Anterior fossa				Middle fossa.				Posterior fossa, cerebral part.				Sum of the lengths of the fossæ.		Skull.		Breadth maximum of frontal region, ventrally.	Length of posterior fossa, cerebellar portion.	
					Diameter antero-posterior maximum.	Diameter lateral maximum.	Cephalic index.	Length.		Index.		Length.		Index.		Length.		Index.				Diameter antero-posterior maximum, ventrally.				
								Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.	Right.	Left.		Right.	Left.
					cm.	cm.		cm.	cm.			cm.	cm.			cm.	cm.			cm.	cm.	cm.	cm.	cm.	cm.	cm.
35.231	Cynocephalus	National Museum.	Adult	Male	9.05	7.60	83.97	3.00	(?)	28.57	(?)	3.40	(?)	32.38	(?)	1.10	(?)	39.05	(?)	10.50	(?)	9.05	(?)	(?)	2.60	(?)
22.062	*Macacus pelops*	do	do	do	8.20	6.80	82.92	2.95	2.95	33.78	33.47	2.85	2.85	31.67	31.32	3.20	3.30	35.55	36.26	9.00	9.10	7.70	7.70	5.4	2.40	2.40
123.516	*Alouata seniculu*	do	do	do	7.00	5.60	80.00	2.30	2.30	31.72	31.08	2.60	2.55	35.86	34.76	2.35	2.55	32.42	34.46	7.25	7.40	5.80	5.95	4.4	2.00	2.10
14.141	*Myctes*	do	do	do	6.35	4.60	72.44	2.30	(?)	31.50	(?)	2.60	(?)	35.35	(?)	2.45	(?)	33.33	(?)	7.35	(?)	6.35	(?)	(?)	1.75	(?)
14.156	*Cebus hypoleucus*	do	do	do	7.50	5.30	70.67	2.35	2.30	31.12	30.67	2.40	2.40	31.79	32.00	2.80	2.80	37.09	37.33	7.55	7.50	6.70	6.70	4.2	1.85	1.90
35.967	*Midas*	do	do	do	4.10	2.85	69.51	1.30	1.30	28.89	29.21	1.50	1.55	33.33	34.83	1.70	1.60	37.78	35.96	4.50	4.45	3.90	3.95	(?)	1.20	1.10
63.345	*Lemur varius*	do	do	do	6.00	4.35	72.50	2.20	2.20	35.48	35.77	2.25	2.25	36.29	36.58	1.75	1.70	28.23	27.65	6.20	6.15	5.30	5.30	3.5	1.60	1.60
35.526	*Ursus americanus*	do	do	do	.....	.....	.....	3.30	3.30	30.56	30.56	3.40	3.50	31.48	32.41	1.10	4.00	37.96	37.09	10.80	10.80	8.60	8.60	6.4	a3.90	3.80
113.391	Deer	do	do	do	.....	.....	.....	3.65	3.55	32.16	31.28	3.30	3.20	29.08	28.19	4.40	4.60	38.76	40.53	11.35	11.35	10.60	10.50	(?)	(?)	(?)
X	Pig	do	(b)	(?)	.....	.....	.....	3.10	(?)	36.90	(?)	2.60	(?)	30.95	(?)	2.70	(?)	32.15	(?)	8.40	(?)	(?)	(?)	(?)	2.20	(?)

a About.

b Adolescent.

A NEW MOLLUSK OF THE GENUS MACROMPHALINA FROM THE WEST COAST OF AMERICA.

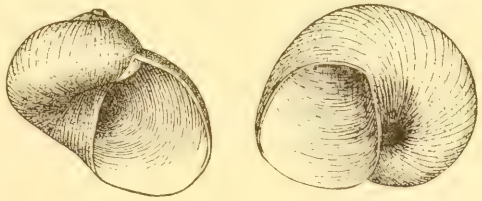
By Paul Bartsch,

Assistant Curator, Division of Mollusks, U. S. National Museum.

While examining a series of small West American shells in the collection of the United States National Museum, two specimens of a new *Macromphalina* were found. That species is here described and figured.

MACROMPHALINA OCCIDENTALIS, new species.

Shell very small, broadly conic with moderately elevated spire, white. Nepionic whorls 2, exceedingly small, smooth and glassy, forming the almost spherical apex. Succeeding turns decidedly inflated, well rounded above, marked by many fine incremental lines and numerous still finer spiral lines, which are equal in strength and closely, equally spaced. Sutures deeply channeled. Last whorl bluntly angulated at the periphery. Base very wide and only moderately rounded, with the umbilical area broadly excavated, marked like the upper surface. Aperture patulous, ovate, the columellar wall forming the narrow end of the oval; outer lip thin, decidedly expanded; columella slender and gently curved; parietal wall very small, covered by a very thin callus, which renders the peritreme almost complete.



a *b*

MACROMPHALINA OCCIDENTALIS. *a*, SIDE VIEW; *b*, BASAL VIEW.

The type has $3\frac{3}{8}$ whorls and measures: Greater diameter 1.7 mm.; lesser diameter 1.2 mm.; altitude 1.3 mm.

The type and another specimen were collected at Point Abreojos, Lower California, and form Cat. No. 126965 of the U. S. National Museum collection.

A REVIEW OF THE FISHES OF THE FAMILY HISTIOPTERIDÆ, FOUND IN THE WATERS OF JAPAN; WITH A NOTE ON TEPHRITIS GÜNTHER.

By David Starr Jordan,

Of Stanford University, California.

In this paper is given an account of the species of fishes, three in number, which represent in Japan the family Histiopteridæ.

Family HISTIOPTERIDÆ.

LONG-NOSED PORGIES OR BOAR-FISHES.

Body deep and compressed, the upper outline forming an unequal curve, the lower nearly straight from the chin to the anal fin, there abruptly angulated. Head relatively low, the profile convex about the eyes, and more or less concave at the base of the projecting snout. Bones of head all covered with rough radiating striæ; no spines on head; edge of preopercle and scapular scale sometimes serrulate; no suborbital stay; no scales on head except on cheeks and temporal region. Mouth small, terminal, the jaws about equal; maxillary small, the proximal part more or less slipping under the edge of the bony preorbital, the distal end covered or free; lips sometimes fringed with small barbels; teeth in narrow bands, those of the outer row more or less evenly enlarged; teeth on vomer sometimes present, none on the palatines. Opercles entire, rugose, as is also the shoulder girdle. Gill-rakers short and thick. Eye moderate, the suborbital bones narrow and rugose. Nostrils double, both ovate. Scales rather small, rough ctenoid. Lateral line complete, strongly arched, not extending on caudal fin. Branchiostegals 7. Gill membranes separate, free from the isthmus. Dorsal fin very high, continuous, the soft rays progressively shortened posteriorly, the spines 4 to 14 in number, strong and rough, not depressible in a groove. Anal with 2, 3, 4, or 5 spines, the second enlarged. Soft dorsal long or short; anal rather short, caudal lunate or truncate. Ventrals I, 5, the spine very strong, the insertion behind that of pectoral fin. Pectoral long, its form not symmetrical, its upper rays longest. Pyloric cæca numerous. Air bladder present, large.

This is a small group of large carnivorous fishes, with rough head, scales, and fins, its members differing considerably among themselves.

It is one of the many offshoots of the Serranidæ, and stands not far from the Lutianidæ and the Hæmulidæ, from both of which it differs in the bony opercle. It is also allied to the Priacanthidæ, from which it differs in the same and in other characters.

The known species are all strongly marked and each might constitute a distinct genus. They are rare in Japan, but when found are valued as food. One of these species is well figured by Schlegel and all three are very well represented by Steindachner and Döderlein. In the following analysis all the known genera of Histiopteridæ are included:

KEY TO GENERA.

a. HISTIOPTERINÆ. Base of soft dorsal much longer than that of spinous dorsal; dorsal spines 4 to 7; anal spines 2 or 3; no teeth on vomer or palatines; chin sometimes with a brush of barbels. Dorsal rays about IV, 28.

b. Dorsal spines 4; anal spines 3; soft dorsal very long and high, but not falcate.

c. Third dorsal spine greatly elevated, longer and stronger than fourth; and nearly as long as soft rays; Japan (*typus*) ..... *Histiopterus*, 1

cc. Third dorsal spine relatively low; much shorter than fourth; which is much lower than soft dorsal. Japan (*acutirostris*) ..... *Evistias*,[a] 2

bb. Dorsal spines 6 or 7, stout, graduated.

d. Anal spines three; soft dorsal very high, falcate; of 26 rays. Australia (*elevatus;* type) ..... *Zanclistius*[a]

d. Anal spines two; dorsal spines seven, the fourth longest and very high; soft dorsal low and short. (D. VII, 17) Australia (*labiosa; farnelli*). *Richardsonia* Castelnau

aa. QUINQUARIINÆ. Base of soft dorsal much shorter than spinous dorsal, the latter with 10 to 14 spines; anal spines 3, 4, or 5; soft dorsal with 10 to 13 rays; teeth usually present on vomer.

e. Anal spines 5; dorsal spines 11 or 12; the soft rays about 15; teeth on vomer—Japan; Cape of Good Hope (*japonicus, capensis.*) . *Quinquarius*,[a] 3

ee. Anal spines 4;

f. Dorsal spines 14. Cape of Good Hope (*richardsoni;* type) .. *Gilchristia*[a]

ff. Dorsal spines 10. Pacific Ocean (*decacanthus;* type) ..... *Quadrarius*[a]

eee. Anal spines three; dorsal spines 10. Anterior profile nearly straight, Australia (*recurvirostris*) ..... *Pentaceropsis* Steindachner

1. HISTIOPTERUS Schlegel.

Histiopterus SCHLEGEL, Fauna Japonica, Poiss., 1843, p. 86 (*typus*).

This genus is characterized by the deep body, suggesting the form of *Chætodon*, the bony head, with projecting jaws, provided with minute barbels, and the sail-like dorsal fin, in which there are four spines, the first two short, the third very long and strong; almost as long as the first soft rays and the fourth, slender and somewhat shorter. Anal spines strong, the second longest and strongest, anterior profile of head relatively even. End of maxillary not covered by preorbital; no teeth on vomer.

(ἱστίον, sail; πτερόν, fin.)

[a] These generic names, *Evistias*, *Zanclistius*, *Quinquarius*, *Gilchristia*, and *Quadrarius*, are here used for the first time. *Gilchristia* is named for Dr. J. D. F. Gilchrist, naturalist, of Cape Colony.

1. HISTIOPTERUS TYPUS Schlegel.

MATODAI (TARGET PORGY), HIDARI MAKI (LEFT-HANDED TWIST).

Histiopterus typus Schlegel, Fauna Japonica, Poiss., 1843, p. 86, pl. xlv (Nagasaki).—Steindachner and Döderlein, Fische Japans, II, 1883, p. 11, pl. ii, fig. 2 (Tokyo, Yokohama).—Ishikawa and Matsuura, Prel. Cat., 1897, p. 58 (Katsuura, Kagoshima).—Smith and Pope, Proc. U. S. Nat. Mus., XXXI, 1906, p. 479 (Kochi).

Habitat.—Southern Japan, north to Tokyo.

Head $2\frac{1}{2}$ in length, depth $1\frac{2}{5}$, B. 7, D IV, 28, A III, 10. Scales 60; eye 4 in head. Anterior profile of head steep and moderately even, the snout projecting. Gill rakers 4 + 14, short and thick, the arch rounded without distinct angle.

Third dorsal spine highest, a little more than half length of body; fourth spine a little shorter and much more slender; soft dorsal much elevated but not falcate, $1\frac{2}{3}$ in body. Ventral half length of body, reaching middle of anal; pectoral about as long as head; second anal spine lower and stronger than third, lower than longest soft rays. Lower jaw with short papillæ on lower side of each ramus. Color dark olive, with about four faint oblique pale cross bands, about one-third width of interspaces. Fins blackish, the pectoral pale with a dark cross shade at its base.

This species is rare in Japan. We have a specimen from Misaki only. It reaches a length of about a foot. Our specimen agrees well with the above account, which is condensed from Steindachner's description.

(*τύπος*, type.)

2. EVISTIAS, new genus.

This genus differs from *Histiopterus* mainly in the form of its spinous dorsal. The spines, four in number, are very stout and of graduated length, the fourth being little more than half the length of the highest soft rays, which are very high, but not falcate. Anal spines three, the second largest, the third longest. Anterior profile of head very irregular, the orbital region and the snout and jaws very prominent. End of maxillary not covered by preorbital; no teeth on vomer.

(*εὖ*, well; *ἱστίον*, sail, for dorsal fin.)

Type of the genus.—Evistias acutirostris.

2. EVISTIAS ACUTIROSTRIS (Schlegel).

TEGUDAI[a] (GOBLIN-PORGY).

Histiopterus acutirostris Schlegel, Fauna Japonica, Poiss., 1843, p. 88 (Nagasaki).—Steindachner and Döderlein, Fische Japans, 1883, p. 12, pl. iii (Tokyo).—Ishikawa and Matsuura, Prel. Cat., 1897, p. 58 (Tokyo).

[a] Tegu (pronounced Tengu) in Japanese mythology is a comical semideity or goblin with a very long nose.

Habitat.—Southern Japan, north to Tokyo.

Head $3\frac{1}{5}$ in length; depth $1\frac{7}{10}$, B. 7, D IV, 29, A III, 13, scales 62. Eye $3\frac{2}{5}$ in head, snout (obliquely measured) $2\frac{1}{5}$. Anterior profile very irregular, the snout and interorbital region very prominent; preorbital very deep. Gill rakers very short and thick, 4 + 16. Dorsal spines stout, graduated, the third about half the fourth, which is a little shorter than head and a little more than half the first soft ray, which is $\frac{1}{3}$ to $\frac{1}{4}$ longer than head; soft rays progressively shortened, the outer edge of the fin slightly convex. Caudal lunate; anal spines stout, the second very strong, a little shorter than third, both much shorter than the soft rays; pectoral and ventral each about as long as head.

Color olive, with six blackish cross bands about as wide as the interspaces, the first at the nape reaching to the eye; the second including first three dorsal spines, base of pectoral, and whole of ventral fin; the third and widest just before vent; the fourth involving base of anal spines; the fifth curved along base of soft dorsal and anal; the fourth narrow, on caudal peduncle. Fins, except ventral and base of pectoral, pale.

This species reaches a length of about 20 inches. It is known as Tegudai, "Snouty Porgy." We have one large specimen, from the market of Yokohama, taken outside the heads, about Awa. It agrees well with Steindachner's account, condensed above.

(*acutus*, sharp; *rostrum*, snout.)

3. QUINQUARIUS, new genus.

Pentaceros CUVIER and VALENCIENNES, Poiss., 1829, III, p. 30 (*capensis*). (Not of Schultze, 1760, a genus of Starfishes).

Body oblong, compressed, pointed anteriorly, the profile not very irregular; dorsal fin with 11 or 12 spines, and 12 to 14 soft rays, the base of the spinous dorsal much longer than that of the soft part; dorsal spines strong, the third longest, the last one a little lower than the soft rays. Anal spines five, the second longest, the last one lower than the soft rays, which are about 9 in number; caudal lunate; pectorals and ventrals long. Scales moderate, firm. Cheeks scaly, bones of head rugose. No teeth on vomer or palatines. Eye large.

(*quinque*, five, from the number of anal spines.)

Type of genus.—*Quinquarius japonicus.*

3. QUINQUARIUS JAPONICUS (Döderlein).

TSUBODAI (BOTTLE-MOUTH PORGY).

Pentaceros japonicus DÖDERLEIN, in Steindachner and Döderlein, Fische Japans, II, 1882, p. 8, pl. v, figs. 1 and 2 (Tokyo).

Habitat.—Southern Japan.

Head, $2\frac{3}{5}$ in length; depth, $1\frac{5}{6}$. B. 7. D. XI, 14. A V, 9. Scales, 47 to 49. Eye, 3 in head. Anterior profile nearly straight, the snout pointed. Third dorsal spine, $1\frac{1}{2}$ in head; soft dorsal rounded, its longest rays about 3 in head. Second anal spine, $2\frac{1}{2}$ in head; soft anal rounded. Color, shining silver gray; paler below ventrals blackish Döderlein).

The species is known from two specimens, 19 to 21 cm. in length, found in the market of Tokyo by Doctor Döderlein. It is probably from Misaki or Awa, outside the heads.

SUMMARY.

1. *Histiopterus* Schlegel 1843.

1. *typus* Schlegel, 1843; Misaki.

2. *Evistias* Jordan 1907.

2. *acutirostris* (Schlegel), 1843; Yokohama.

3. *Quinquarius* Jordan 1907.

3. *japonicus* (Döderlein), 1882.

NOTE ON *TEPHRITIS* OR *VELIFRACTA*.

I may here note that the name *Tephritis* Günther (1862), applied to a genus of Chinese flounders, is preoccupied among flies (*Tephritis* Fabricius 1794). The genus of flounders may be named *Velifracta*, using a term applied by Richardson to the type-species, *Velifracta sinensis* (Lacépède). A good figure of this species is published by Jordan and Seale, in Proc. Davenport Acad. Sci., X, 1905, pl. XI.

ON THE METEORITE FROM RICH MOUNTAIN, JACKSON COUNTY, NORTH CAROLINA.

By George P. Merrill,
with chemical analyses by Wirt Tassin,
Of the U. S. National Museum.

The meteorite described below was received at the United States National Museum from Prof. H. H. Brimley, curator of the State Museum at Raleigh, North Carolina. To him I am also indebted for most of the information relative to its fall.

The exact date of fall can not be given, but it is stated as "about the 20th of June, 1903, and 2 o'clock in the day." Concerning the phenomena of the fall, the following is gleaned from a letter of Mr. E. A. Cook, of Rich Mountain, to Mr. Brimley:

"It [the meteorite] was going nearly due south; I did not see it, though it passed directly over my place. It made a rumbling sound something like a tornado of wind, or the pouring of water." The explosion Mr. Cook compares to a "large blast," the first and loudest being followed by lesser sounds, compared to the shooting of a self-acting pistol. Reports from the adjacent parts of South Carolina were to the effect that the passage of the stone was heard and seen there, and it created great excitement. It was also seen by people living 10 miles northwest of Rich Mountain, who reported it as looking like a ball of fire the size of a flour barrel. The single piece secured (See Plate XVI) passed through the top of a green tree, cutting off the leaves and small limbs, and struck the ground not more than 40 feet from a man standing in a field, who dug it up and gave it to Mr. Cook. Other fragments were reported to have been found across the State line in South Carolina. Such, however, have not come into the possession of the writer, nor has he been able to get track of them. The single piece which has thus far come to light is that shown in Plate XVI, which weighed 668 grams; actual size, 122 mm. in length; 76 mm. in breadth by 44 mm. in thickness. This is

obviously a freshly broken piece from a larger mass, the crust on the flat surface (lower side in fig. 1) being very thin, not nearly equal to that on the rounded surface. There is no fluting or grooving to indicate the orientation during flight, but the smoothness of the rounded point (upper left in fig. 1) suggests at least that this formed the nose or breast of the stone in its passage through the air. The proximity of this locality to that of the Hendersonville meteorite recently described by the writer [a] might at first suggest that it represented a part of the same fall. The testimony of eyewitnesses to the phenomenon and the freshness of the sample as compared with the last named, however, preclude any such conclusion. The close similarity of the stone to that of Bath Furnace, Kentucky, as described by Ward [b] is also worthy of note, although there is an interval of over six months between the dates of fall.

The black crust is dull, and somewhat rough. On the recently broken, flat surface, where the crust is thinnest, and on the rounded surface the metallic iron particles project, seemingly having resisted the frictional heat of the atmosphere more than did the silicate portions. This is shown plainly in fig. 2 of Plate XVI. A cut surface shows a gray, compact, indistinctly chondritic structure, with gray and more rarely white "kugels" and an about medium scattering of metallic iron and troilite. The texture is coarser, less compact, and in color a lighter gray than that of the Hendersonville stone, but closely like that of Bath Furnace. The stone is traversed by numerous fine, thread-like, black veins, often branched, and without common orientation. Although sought for with care, no certain indication of movement along these lines could be discovered. Indeed, the evidence was almost wholly to the contrary, the veins sometimes passing directly through the chondrules without evident relative displacement of the portions thus separated.

Under the microscope the structure is somewhat obscure, the chondrules being often fragmental and not strongly differentiated from the fine, pulverulent ground. Olivine and enstatite, the latter prevailing, with an occasional monoclinic pyroxene, are the principal silicate constituents, the first named in chondrules of the polysomatic and barred type, and in scattered granules; the enstatite in cryptocrystalline radiate forms, granules, and occasional relatively large, almost colorless and clear plates. Interspersed with these are minute colorless areas, showing no crystalline outlines, cleavage, or other evidences of crystal structure, little relief and polarizing only in light and dark colors. These areas are at times so abundant as to form the base in which the other constituents are embedded. They are evidently com-

[a] Proc. U. S. Nat. Mus., XXXI, 1907, pp. 79–82.
[b] Proc. Rochester Acad. of Sci., IV, 1905, p. 192.

posed of a single mineral, the optical properties of which are so ill-defined as to make a satisfactory determination impossible. At times it is quite isotropic, but more commonly it shows a faint double refraction, and in a very few instances the attempt at obtaining an interference figure resulted in a very indistinct dark brush, suggestive of a biaxial mineral. Between crossed nicols, if not always dark, it shows no definite extinction plane, but the dark wave sweeps over the surface much as in an isotropic mineral in a condition of strain. In a single instance one of these areas adjoined and partially inclosed a minute particle showing the parallel twin bands of a plagioclase feldspar. The mineral is regarded as unquestionably the same as that so common under similar conditions in the meteorite of Alfianello, Italy, and which has been considered by V. Toullon[a] as maskelynite, a conclusion adopted by Tschermak.[b] The present writer also noted its occurrence in the recently described meteoric stone from Coon Butte, Arizona.[c] Compared with terrestrial rocks, it is of interest to note that similar structures and associations of pyroxene or olivine, and what are unquestionably feldspars, are found in peridotites of the wherlite type, as described[d] by the writer some years ago from the Red Bluff region of Montana.

In addition to the above is an occasional plate of a colorless silicate likewise of a doubtful nature. The plates are of irregular outline, faintly gray or almost completely colorless, and show very faint, short, sharp cleavage lines, and rarely any inclosures of other minerals which are so conspicuous a feature of the maskelynite. The surface viewed under a high power has a peculiar roughness, in which also it differs from the above. Between crossed nicols it gives weak polarization colors, and is optically biaxial, though good interference figures are not obtainable. The description given by Tschermak[e] of a mineral referred to as possibly monticellite would apply equally well to this, though the present writer confesses to a considerable feeling of doubt as to its true nature.

The structure and composition of the stone, as a whole, is comparable with those of Lancon, France, and Bath Furnace, Kentucky (Cia). It will be known as the Rich Mountain meteorite.

CHEMICAL ANALYSIS BY MR. WIRT TASSIN.

A very small portion of the meteorite, 5.8 grams in all, was available for analysis. This was treated in the usual way, the native metals (I), sulphur (II), phosphorus (III), soluble and insoluble silicates (IV

[a] Sitz. Wien. Akad., LXXXVIII, 1883, p. 433.

[b] Die Mikroskopische Beschaffenheit der Meteoriter, see especially pl. XVII, fig. 2.

[c] Am. Jour. Sci., XXI, May, 1906, p. 347.

[d] Proc. U. S. Nat. Mus., XVII, 1895, p. 651.

[e] Sitz. Wien. Akad., LXXXVIII, Pt. 1, 1883, p. 355.

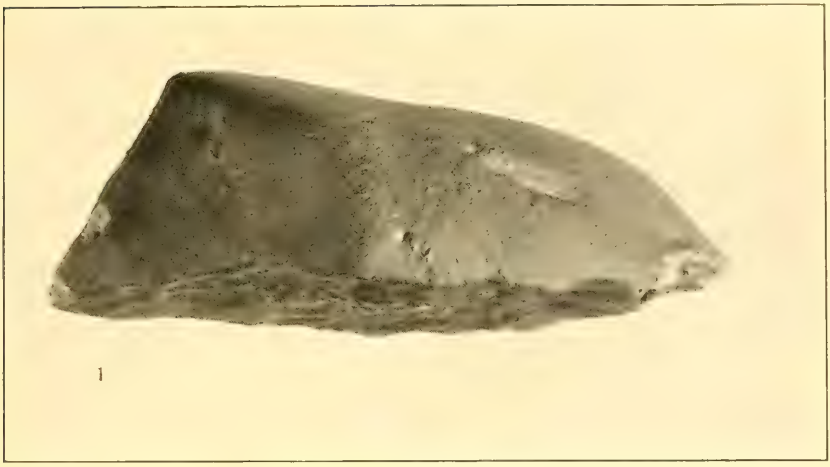
and V), and the alkalies (VI), each being determined in separate portions. The values obtained are as follows:

I.	Fe	7.07
	Ni	.73
	Co	.031
II.	S	1.42
III.	P	.03
IV.	SiO_2	18.28
	FeO	9.06
	Al_2O_3	.50
	CaO	.99
	MgO	18.16
V.	SiO_2	23.00
	FeO	4.92
	Al_2O_3	2.10
	CaO	1.51
	MgO	8.27
	Fe_3O_4 (magnetite)	.15
	C (graphite)	.015
VI.	K_2O	.16
	Na_2O	.68

From these several values the approximate composition of the mass may be arrived at as given below:

Iron	7.070	Insoluble silicates	40.670
Nickel	.730	Magnetite	.150
Cobalt	.031	Graphite	.015
Troilite	3.890		
Schreibersite	.200		99.736
Olivine	46.990		

In the analyses above given the absence of copper in the native metals and chromite among the compounds is to be noted. Attention is also to be called to the presence of carbon as graphite, occurring as graphitic chondrules, which may or may not be contained in or surrounding particles of the native metals. The occurrence of the graphite is especially interesting, since the relatively large amounts of it do not appreciably affect the color of the groundmass.



THE RICH MOUNTAIN, NORTH CAROLINA, METEORITE.

The relative position of the stone in the two views may be judged by noting the elongated depression on the upper surface and to the right in fig. 1. In fig. 2 the stone has been simply tipped so that the front edge in fig. 1 is at the bottom in fig. 2.

A REVIEW OF THE FISHES OF THE FAMILY GERRIDÆ FOUND IN THE WATERS OF JAPAN.

By David Starr Jordan,

Of Stanford University, California.

In this paper is given an account of the species of fishes belonging to the family Gerridæ found in the waters of Japan. It is based on the collections of Professors Jordan and Snyder, series of which are in the United States National Museum. The species, two in number, are known to the Japanese as Kurosagi (*kuro*, black, *sagi*, heron, the same word used for smelt).

Family GERRIDÆ.

Body oblong or elevated, compressed, covered with large, smooth scales; lateral line continuous, concurrent with the back; mouth moderate, extremely protractile, descending when protruded, the spines of the premaxillary extending to above eye, closing a deep groove in the top of head; maxillary without supplemental bone, not slipping under the very narrow preorbital, its surface silvery, like the rest of the head; base of mandible scaly, a slit between it and the preorbital to permit its free motion; jaws each with slender, villiform teeth; no incisors, canines, nor molars; no teeth on vomer or palatines; preopercle entire or serrate; sides of head scaly; nostrils double, round; pseudobranchiæ concealed; gillrakers short, broad; gill-membranes separate, free from the isthmus; dorsal fin single, continuous or deeply notched, the spinous and soft portions about equally developed, with a scaly sheath along the base; dorsal spines 9 or 10; anal with 2, 3, or 5 spines, usually with 3 spines, the soft portion of the fin similar to the soft dorsal, but shorter; ventral fins thoracic, I, 5, rather close together, slightly behind pectorals, branchiostegals 6; lower pharyngeal bones close together, often appearing to be united; the teeth blunt; air-bladder present; pyloric cœca rudimentary; vertebræ $10 + 14 = 24$. Oviparous. Carnivorous fishes of moderate size inhabiting sandy shores of tropical and subtropical seas.

KEY TO GENERA.

a. GERRINÆ. Dorsal fin continuous, deeply notched; anal spines, 3 or 2.
b. Second interhæmal spine normally developed, not forming a hollow cylinder, the air-bladder not entering it, but its tip forking, extending on each side of it.
c. Second interhæmal spine long, spear-shaped, anal spines 3.
d. Preopercle entire; second anal spine moderate.
e. Dorsal spines, 9 ..... *Xystæma*, 1
ee. Dorsal spines, 10 ..... *Gerreomorpha*, 2

1. XYSTÆMA Jordan and Evermann.

Xystæma JORDAN and EVERMANN, Proc. Cal. Ac. Sci., 1895, p. 471 (*cinereus*).

This genus differs from *Gerres* in having the preopercle entire. The body is compressed, but not greatly elevated, and the second anal and fourth dorsal spines are less enlarged than in *Gerres*. Dorsal spines always 9; anal spines, 3. The second interhæmal is long and spear-shaped, not hollow, and not receiving the air-bladder, its structure as in *Gerres*. Usually the air-bladder is forked, passing on each side of the interhæmal spine. Species numerous, chiefly Asiatic, only the type-species being American.

(ξυστόν, spear-shaft; αἷμα, blood, for interhæmal.)

1. XYSTÆMA ERYTHROURUM (Bloch).

KUROSAGI (BLACK SMELT), AMAGI (SWEET-FISH), SIJUGARA (CHICKADEE.)

Sparus erythrourus BLOCH, Ichth, VIII, 1790, p. 23, pl. CCLXI (Japan).
Gerres equula SCHLEGEL, Fauna Japonica, Poiss., 1843, p. 76, pl. XL, fig. 1 (Nagasaki).—BLEEKER, Nieue Nalez, Japan, XXV, 1857, p. 92 (Nagasaki).
? *Gerres japonicus* GÜNTHER, Cat., IV, 1862, p. 260 (Amoy; Canton. Said to have D. IX, 10). (Not of Bleeker.)
? *Gerres japonicus* RUTTER,[a] Proc. Ac. Nat. Sci., Phila., 1897, p. 76 (Swatow, China).
Xystæma oyena SMITH and POPE, Proc. U. S. Nat. Mus., XXXI, 1906, p. 478 (Yamagawa, near Kagoshima). (Not of Forskål).

Habitat. Southern Japan, perhaps southward to China, common in sandy bays northward to Wakanoura.

Head 3½ in length; depth 2⅝ to 3; D. IX, 10; A. III, 8; eye 3 to 3⅓ in head; scales 4½–44–9.

Body elliptical-compressed, rather more elongate and less angular than usual in *Xystæma;* silvery part of maxillary about twice as long as deep; groove on top of head short, obtuse behind; dorsal rather low, its longest spine 1⅔ to 1⅗ in head; second anal spine 3 to 3⅓ in head; pectoral as long as head; ventral 1½ in head; distance from ventral base to anal greater than length of head; gillrakers very short and sharp, 5+7.

[a] This specimen having the depth 2⅔ in length, the anal spine ⅔ depth of body, must belong to a distinct species, perhaps *Xystæma oyena*.

Color silvery, rather darker above than usual; faint dark shades along bases of soft dorsal rays; tip of spinous dorsal black; tips of ventrals more or less dusky; axil of pectoral rarely entirely pale, usually dark; ventrals and front of anal yellow in life.

Of this species, common on sandy shores throughout southern Japan, we have many specimens from Nagasaki, Wakanoura, and Oita, in Bingo. It is an elongate species, with the back dusky and the fin spines

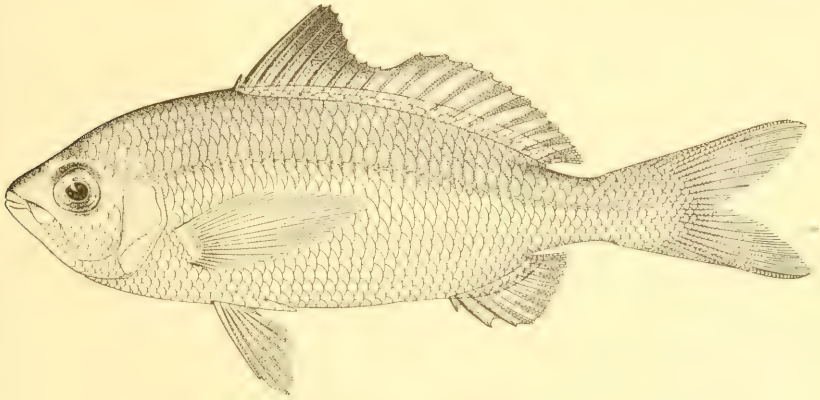


FIG. 1.—XYSTÆMA ERYTHROURUM.

low. It has been confounded with *Xystæma oyena* (Forskål), of India and Arabia, but it is apparently distinct. The latter is a deeper fish, with the caudal dusky behind and the ventrals pale.

(ἐρυθρός red; οὐρά tail, which is not the case; Bloch's type was doubtless discolored.)

2. GERREOMORPHA Alleyne and Macleay.

Gerreomorpha ALLEYNE and MACLEAY, Proc. Linn. Soc. N. S. W., I, 1876, p. 274 (*rostrata*).

This genus differs from *Xystæma*, and from all other *Gerridæ*, in having ten dorsal spines instead of nine. The type is Australian. *Gerreomorpha setifera* (Hamilton-Buchanan) is an Indian species of this genus.

(Gerres; μορφή, form.)

2. GERREOMORPHA JAPONICA (Bleeker).

Gerres japonicus BLEEKER, Nieue Nalez, Japan, 1857, p. 93, pl. v (Nagasaki).—NYSTRÖM, Svensk. Vet. Ak. Handl., 1887, p. 12 (Nagasaki).

Xystæma japonicum SMITH and POPE, Proc. U. S. Nat. Mus., XXXI, 1906, p. 478 (Kochi; Urado).

Habitat.—Bay of Waka, to Nagasaki and southward to the Riu Kiu Islands; rare.

Head $3\frac{2}{5}$ in length; depth $2\frac{3}{5}$; eye $3\frac{1}{3}$ in head; D. X, 9; A. III, 7; scales $5\frac{1}{2}$–42–9.

Body deeper and more angulated than in *Xystæma erythrourum;* groove of premaxillary short, obtuse behind; silvery part of maxillary about half longer than deep; snout not projecting; outline of lower jaw slightly concave; longest dorsal spine $1\frac{3}{5}$ in head; longest anal spine $2\frac{4}{5}$; pectoral as long as head.

Color silvery, darker above, with faint darker streaks along the rows of scales; tip of dorsal blackish; axil of pectoral dusky; ventrals not tipped with black; ventrals and membranes of anal spines yellow in life; caudal greenish.

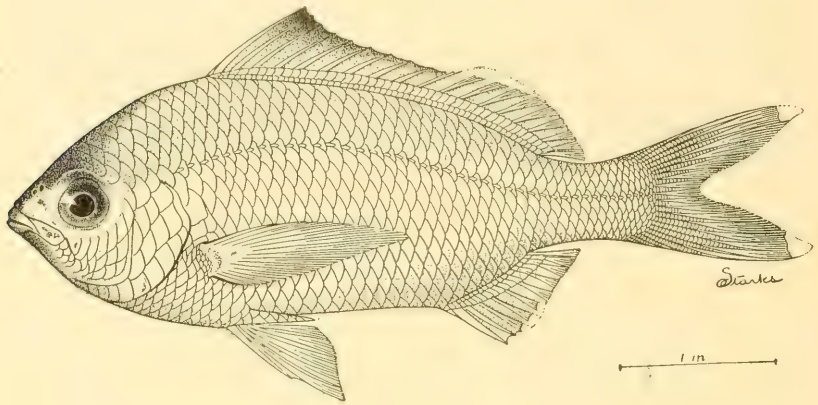


FIG. 2.—GERREOMORPHA JAPONICA.

Of this species we have examined three specimens, two from Naha in the Riu Kiu Islands, presented by the Imperial University. The other was taken by Messrs. Jordan and Snyder at Wakanoura. The species may be known at once by the very silvery coloration, by the rather deep body and by the character, called generic, of the ten dorsal spines.

SUMMARY.

Family GERRIDÆ.

1. *Xystæma* Jordan and Evermann, 1895.

1. *erythrourum* (Bloch) 1790; Wakanoura, Oita, Nagasaki.

2. *Gerreomorpha* Alleyne and Macleay, 1876.

2. *japonica* (Bleeker) 1857; Wakanoura, Naha (Riu Kiu Islands).

SOME MADREPORARIAN CORALS FROM FRENCH SOMALILAND, EAST AFRICA, COLLECTED BY DR. CHARLES GRAVIER.

By T. Wayland Vaughan,

Custodian, Madreporaria, U. S. National Museum, and Geologist, U. S. Geological Survey.

Doctor Charles Gravier, of the Muséum d'Histoire Naturelle, Paris, kindly submitted to me for study and report that portion of the collection of corals made by him in 1904, in French Somaliland, that would safely bear transportation to this country. I accordingly received the so-called Astreans, the Fungids, the Astreopores, and the Goniopores. The type specimens, in the case of new forms, are the property of the Paris Museum; but paratypes or fragments of the types are in the United States National Museum.

As the collection was obtained at a locality just outside the mouth of the Red Sea, it is of special interest for comparison with the faunas of the Red Sea, the East Coast of Africa, and the regions farther to the east in the Indian Ocean.

I desire to express my thanks to Mr. J. Stanley Gardiner, of Gonville and Caius College, Cambridge, for kindly comparing photographs and my descriptions of *Orbicella annuligera* and the Cyphastreæ with his specimens from the Maldive and Laccadive archipelagoes.

Genus PHYSOGYRA Quelch.

1886. *Physogyra* Quelch, Reef Corals, "Challenger" Reports, p. 75.

Quelch established this genus for a coral that he described as *Physogyra aperta*, from Banda, and the *Pleurogyra lichtensteini* Milne Edwards and Haime, of unknown habitat. The latter species has not, to my knowledge, been figured. Doctor Gravier obtained two species, which are subsequently described, from French Somaliland. In order to show the differential characters of the four recognized species I have prepared the following synopsis:

SYNOPSIS OF THE SPECIES OF PHYSOGYRA.

Without wall ridge on the colline summits:

Upper margins of the septa arched or flattened ..... *P. somaliensis*, new species.

With wall ridge on the colline summits:

Valley axes narrow and deep.

Valleys, 15 to 18 mm. wide; septa, 2 to 3 mm. apart.

P. lichtensteini Milne Edwards and Haime.

Valley axes open and shallow.

Upper margins of the septa arched or flattened; valleys, 16 to 20 mm. wide; septa, 2 to 4 mm. apart ..... *P. aperta* Quelch.

Upper margins of the septa, distally abruptly elevated; valleys, 11 to 18.5 mm. wide; septa, 1.4 to 2 mm. apart, occasional intermediate rudimentaries ..... *P. gravieri*, new species.

PHYSOGYRA SOMALIENSIS, new species.

Plate XVII.

Apex of the base small, surmounted by a short, thick pedicel. The lower surface more or less corrugated concentrically, ascending at a low angle, with the margins in some instances slightly bent downward. Costæ correspond to many or most of the septa; no epitheca; wall largely dissepimental in origin, often presenting a glazed appearance. The reflexed edge zone may extend some distance from the margin, or foreign objects may incrust the base to near the periphery. The upper surface is gently domed. The corallum is very vesicular and for its size extremely light.

Table of measurements.

Specimen.	Diameter.		Height.
	Greater.	Lesser.	
	mm.	*mm.*	*mm.*
No. 1	76	71	54
No. 2	134	121	83
No. 3[a]	161	150	80

[a] Figured type, Museum d'Histoire Naturelle, Paris.

Valleys more or less radiate in arrangement; longitude, up to 120 mm. on specimen No. 3; distance between the summits of adjacent collines, from 11 to 18 mm.; depth, about 8 mm. Calicinal centers distinct or indistinct.

Septa thin, distant, usually alternating in prominence, the taller, which are somewhat unequal, continuing to the summit of the collines, while the smaller ones, which usually are decidedly rudimentary, appear farther down on the sides of the collines in the loculi between the larger. There are 7 to 8 larger septa to the centimeter, and approximately the same number of smaller ones. The septal margins are entire; their upper portion gently arched or flattened, the outer ends may connect with the septa of the next series, or they may end abruptly on the colline summit; the inner margins fall abruptly to the bottom of the narrow axial furrow.

Dissepimental endotheca highly developed, forming vesicular ridges from 7.5 to 16.5 mm. across; dissepiments thin, from 1 to 2 mm.

apart; they arch upward and may reach, or very nearly reach the highest points of the septa. The collines composed of dissepiments and the outer ends of the septa; there is no wall lamella.

Columella poorly developed, consisting of a few septal processes, or absent.

Type.—Muséum d'Histoire Naturelle, Paris.

Paratype.—United States National Museum.

Remarks.—This species differs from the other three species of the genus by the absence of a wall ridge or lamella, and by having more numerous septa.

PHYSOGYRA GRAVIERI, new species.

Plate XVIII, figs. 1, 2.

Corallum very vesicular and light; subdiscoid in shape, with a thin, slightly reflexed edge. Greater diameter, 141 mm.; lesser, 125 mm.; height, 57 mm. The lower surface is almost, but not entirely, without epitheca; the edge zone evidently extended a considerable distance beneath the periphery, but there are some serpula tubes and molluscan shells attached to the base. The basal wall is largely dissepimental in origin, but apparently not entirely of that nature. Prominent, thin costæ correspond to most of the septa.

Upper surface gradually rounded. Colline summits indicated by an imperfect, discontinuous, perforate wall; the distal ends of the septa elevated at a sharp angle.

Valleys more or less radiate in arrangement, rather straight or sinuous, they may be long, as much as 119 mm. in length; distance between colline summits, from 11 to 18.5 mm.; depth about 6 mm., but as the wall and the elevated distal ends of the septa form a ridge from 2 to 3.5 mm. tall, the valleys are really decidedly shallow. Calicinal centers distinct, average about 1 cm. apart.

Septa thin, distant, 5 to 7 large ones to the centimeter, with occasional intervening rudimentaries. The larger continue to the summits of the collines and, as has been stated, have their outer ends suddenly elevated and joined one to another by an imperfectly developed wall. The septal margins are microscopically dentate and form somewhat sinuous lines from points slightly above the base of the wall ridge to irregularly developed, somewhat ragged paliform lobes that surround the calicular axis. The inner edges of the lobes are steep, and surround the rather shallow calicinal centers.

Dissepimental endotheca very highly developed, forming vesicular collines that extend across from the bottom of one valley to that of the next, and arch upward to within 2 to 3.5 mm. of the wall summit. Dissepiments thin, arched, from 1 to 3 mm. apart.

Columella poorly developed, false, consisting of a few spinose processes from the inner ends of the septa.

Type.—Muséum d'Histoire Naturelle, Paris; a portion of the type in the United States National Museum.

Remarks.—The three particularly noteworthy characters of this species are, (*a*) the imperfectly developed, but elevated wall ridge; (*b*) the open, shallow valleys; (*c*) the sudden elevation of the septal margins along the colline summits. The last-mentioned character separates it from any of the previously described species.

Genus ORBICELLA Dana.

ORBICELLA MINIKOIENSIS Gardiner.

1904. *Orbicella minikoiensis* GARDINER, Madrepor., Maldive and Laccadive Archipel., II, p. 774, pl. LXIII, fig. 35.

One fine specimen of this species, so similar to Gardiner's figure that it might have served as the type, was obtained.

ORBICELLA (LEPTASTREA) INÆQUALIS Klunzinger.

1879. *Leptastræa inæqualis* KLUNZINGER, Korallth. Roth. Meer., Pt. 3, p. 45, pl. v, fig. 6.

One specimen about the size of a man's fist was collected.

ORBICELLA (LEPTASTREA) BOTTÆ (Milne Edwards and Haime).

1850. *Cyphastrea? bottæ* MILNE EDWARDS and HAIME, Ann. Sci. nat., 3 ser., zool., XII, p. 115.

1857. *Cyphastræa bottai* MILNE EDWARDS and HAIME, Hist. nat. Corall., II, p. 486, pl. XLVII, fig. 1.

1879. *Leptastræa bottai* KLUNZINGER, Korallth. Roth. Meer., Pt. 3, p. 44, pl. v, fig. 6; pl. x, figs. 13*a*, 13*b*.

Two specimens were procured.

ORBICELLA ANNULIGERA (Milne Edwards and Haime).

Plate XX, fig. 3; plate XXI; plate XXII, fig. 4.

1850. *Astrea annuligera* MILNE EDWARDS and HAIME, Ann. Sci. nat., 3 ser., Zool., XII, p. 103.

1857. *Heliastræa annuligera* MILNE EDWARDS and HAIME, Hist. nat. Corall., II, p. 471.

1904. *Orbicella annuligera* GARDINER, Madrepor., Maldive and Laccadive Archipel., II, p. 774, pl. LXIII, fig. 32.

One specimen was submitted to me, and on it the following description is based:

Corallum of irregular shape, growth-form massive, attached by a portion of the lower surface; calices confined to the upper surfaces and the edges. There is no epitheca on the base, but outside the outer corallites there is considerable vesicular exotheca. The outer surface of this exotheca presents a minutely blistered and granulated appearance, with longitudinal costal striations that become more prominent on the periphery. Length, 152 mm.; width, 94 mm.; height, 86 mm.; thickness of living portion, 42 mm

Calices circular or subelliptical, shallow, about 1 mm. deep, diameter from 3 to 3.5 mm., an occasional abnormal calice, 5 mm. The margins elevated about 1 mm. The free portion of the corallites below the calices is somewhat swollen and strongly costate, the costæ alternating in thickness and prominence, the larger prolonged and meeting those of the adjoining corallites. Distance between calices from 1 to 2.75 mm., usually about 2 mm.; the distance apart is less than the diameter.

The septa normally form three complete cycles, occasionally a few quaternaries; primaries and secondaries stout, equal or subequal, and joined by wide prominent pali to the columella. The tertiaries are somewhat thinner, bear no pali, reach a little less than half the distance from the wall to the columella and nearly always have their inner ends free. All of the septa are thicker in the thecal ring and have costæ, which have already been described, corresponding to their distal ends. The margins are finely dentate, somewhat elevated, arching above the edge of the wall; primaries and secondaries more prominent than the tertiaries. Septal faces minutely and densely granulate.

The pali are thick, wide, equaling in width the length of the septa, prominent, with an arched, finely dentate upper margin. They form a single crown, occur before the primaries and secondaries, which they join to the columella. Their faces granulate.

Thin endothecal dissepiments present; a coarser, vesicular, highly developed exotheca occurring between the costæ.

Columella well developed, rather compact, bearing several papillæ on its upper surface.

Remarks.—In those calices in which quaternaries are present, one or more of the tertiaries becomes elongated, paliferous, and fuses to the sides of a septum belonging to a lower cycle or extends to the columella. A few much enlarged calices have more numerous septa. Asexual reproduction is usually by budding between the calices, or by peripheral gemmation around the edges of the corallum, but among the abnormally large calices fission occurs.

Mr. J. Stanley Gardiner has compared photographs of this specimen and my description with his specimens from Minikoi and Goidu, and writes me that they are the same.

Genus CYPHASTREA Milne Edwards and Haime.

CYPHASTREA FORSKALIANA (Milne Edwards and Haime).

Plate XIX; plate XX, figs. 1, 2; plate XXII, figs. 1, 2, 3. (Plate XIX, plate XX, fig. 1, and plate XXII, fig. 2, are of one specimen; plate XX, fig. 2, and plate XXII, figs. 1, 3, are of another.)

1850. *Solenastrea forskaliana* Milne Edwards and Haime, Ann. Sci. nat., 3 ser., Zool., XII, p. 123.

1904. *Cyphastræa forskaelana* Gardiner, Madrepor., Maldive and Laccadive Archip., II, p. 778.

Corallum of light texture, but of massive growth-form. Upper surface irregularly convex, with gentle undulations and some large humps; lower surface concave, with irregular, concentric corrugations and an epitheca that extends almost to the edge. Greatest length, 128 mm.; width, 67 mm.; height, 70 mm.; thickness of living portion, up to 25 mm.

Calices usually with slightly elevated margins, varying in height from a small fraction of a millimeter to 1 mm.; in some instances not raised above the exothecal surface. Their diameter from 1.5 to 2.5 mm., usually from 1.8 to 2 mm. Distance apart from 1 to 3 mm.; on the upper portion usually about 1.5 mm.; near the edges more distant. The calices are generally smaller and more crowded in the depressions; larger and more distant on the convexities.

The septa form three complete cycles, the primaries and secondaries reach the columella, but the former are slightly thicker; the tertiaries are short and thin, almost rudimentary. The outer ends of the septa are continued beyond the corallite wall and form distinct, rather acute costæ, alternating in size. The septa are thicker in the mural ring, becoming thinner outwardly toward the costal edges and inwardly toward the inner ends. The margins are exsert, steeply arched, the primaries and secondaries exceeding the tertiaries in height; the summit of the arch very obscurely dentate or entire, the inner and outer edges distinctly dentate; near the columella there are rather long teeth. The septal faces are densely granulated. Calicular fossa of moderate depth, about 1.5 mm. Columella vesiculate, very well developed, joining the inner ends of the primaries and secondaries.

In longitudinal sections of the corallites, the septa show numerous, irregularly disposed perforations, and many very delicate dissepiments.

The corallites are joined by a very vesicular exotheca, whose upper surface is composed of numerous blistery elevations that bear a great many small pointed spines. In a section of the corallum the exothecal vesicles are seen to occur in rather definite zones, about 0.5 mm. apart, the upper of any two zones being supported by the spines of the lower one.

Remarks.—A second specimen of *Cyphastrea*,[a] which I believe should be referred to the same species, differs in a few particulars from the specimen just described. The differences are contained in the following notes:

Corallum of somewhat deformed, ellipsoidal shape, with calices distributed over its entire surface. Length, 67.5 mm.; greater diameter, 55 mm.; lesser diameter, 54 mm.

Calicular margins practically level with the exothecal surface, or slightly elevated above it, in one extreme instance about 1.3 mm. tall,

[a] Cf. Plate XX, fig. 2, and plate XXII, figs. 1, 3.

but about 0.5 mm. is an average. Diameter of calices from 1.5 to 2 mm.; distance apart, from 1 to 2.5 mm., usually equaling or slightly exceeding the diameter.

The septa usually form three complete cycles; primaries and secondaries of the same size, extending to and fusing by their inner ends with the columella; the tertiaries are short and thin.

A comparison of the two descriptions shows that the only real difference is the form. Since in all other characters they are identical, or as each specimen shows within itself sufficient variation to overlap with the other, I think that difference is not of specific value.

Klunzinger[a] places "*Solenastræa forskalana* M. Edw. and H." in the synonymy of *Madrepora serailia* Forskål, employing the name *Cyphastræa serailia*. Doctor Gravier's specimen agrees perfectly with the description of Milne Edwards and Haime, and differs in no important particular from the specimens described by Gardiner from Hulule, but I do not feel at all sure that it is the same as Klunzinger's *Cyphastræa serailia*. It is to be regretted that Doctor von Marenzeller has not given us some notes on Forskål's type and additional information on the material studied by Klunzinger.

Genus APHRASTREA Milne Edwards and Haime.

APHRASTREA DEFORMIS (Lamarck).

1816. *Astrea deformis* LAMARCK, Hist. nat. Anim. sans Vert., II, p. 264.
1848. *Aphrastrea deformis* MILNE EDWARDS and HAIME, Ann. Sci. nat., 3 ser., Zool., X, pl. IX, figs. 11, 11*a*.
1849. *Aphrastrea deformis* MILNE EDWARDS and HAIME, Ann. Sci. nat., 3 ser., Zool., XII, p. 165.
1904. *Aphrastræa deformis* GARDINER, Madrepor., Maldive and Laccadive Archipel., II, p. 773, pl. LXIII, fig. 31.

A single excellent specimen that shows no noteworthy peculiarity was obtained.

Genus ECHINOPORA Lamarck.

ECHINOPORA EHRENBERGII Milne Edwards and Haime.

1849. *Echinopora ehrenbergi* MILNE EDWARDS and HAIME, Ann. Sci. nat., 3 ser., Zool., XII, p. 187.
1879. *Echinopora ehrenbergi* KLUNZINGER, Korallth. Roth. Meer., Pt. 3, p. 56, pl. VI, figs. 7, 9; pl. X, fig. 15.

A small, young specimen of *Echinopora*, attached to the base of a specimen of *Orbicella hottæ*, was collected at Djibouti. As the specimen is immature, its identification is not entirely positive, but it seems to be *E. ehrenbergi*.

[a] Korallth. Roth. Meer., Pt. 3, p. 52, pl. V, fig. 4; pl. X, figs. 12*a*, 12*b*.

Genus FAVITES Link.

FAVITES SPINOSA (Klunzinger).

1879. *Prionastræa spinosa* KLUNZINGER, Korallth. Roth. Meer., Pt. 3, p. 39, pl. IV, fig. 7; pl. X, fig. 5.

Two specimens showing no special deviation from Klunzinger's description or figures were collected.

Genus FAVIA Oken.

FAVIA OKENI Milne Edwards and Haime.

1857. *Favia okeni* MILNE EDWARDS and HAIME, Hist. nat. Corall., II, p. 430.
1879. *Favia cavernosa* KLUNZINGER, Korallth. Roth. Meer., Pt. 3, p. 26, pl. III, fig. 4. (Not Forskål.)
1904. *Favia cavernosa* GARDINER, Madrepor., Maldive and Laccadive Archipel., II, p. 767, pl. LXI, fig. 13.
1906. *Favia okeni* v. MARENZELLER, Riffkorall. Roth. Meer., p. 59.

Von Marenzeller studied the type specimen of Forskål's *Madrepora cavernosa* in Copenhagen and says that Klunzinger's identification is erroneous. Forskål's species groups with *Favia savignyi* Milne Edwards and Haime.

Doctor Gravier collected four specimens. They show considerable variation, particularly in the thickness of the septa and costæ, but a detailed description seems superfluous.

FAVIA SAVIGNYI (Milne Edwards and Haime).

1849. *Parastrea savignyi* MILNE EDWARDS and HAIME, Ann. Sci. nat., 3 ser., Zool., XII, p. 173.
1879. *Favia clouei* KLUNZINGER, Korallth. Roth. Meer., Pt. 3, p. 29.
1879. *Favia ehrenbergi* KLUNZINGER, Korallth. Roth. Meer., Pt. 3, p. 29, pl. III, figs. 5, 7, 8; pl. IX, figs. 1*a*, 1*b*.
1904. *Favia versipora* GARDINER, Madrepor., Maldive and Laccadive Archipel., II, p. 766.
1906. *Favia savignyi* v. MARENZELLER, Riffkorall. Rot. Meer., p. 56, pl. XXV, figs. 84–89.

This species is represented by a suite of fifteen specimens that show a great amount of variation. Klunzinger and von Marenzeller, however, have described the variations of the species with such elaborateness that I shall not describe this suite. Klunzinger's figures, plate III, figs. 7, 8, represent these specimens very well; the calices of von Marenzeller's specimens are larger, judging by his figures. The Gravier specimens otherwise show the same range of variation, except Klunzinger's variety *laticollis* is not represented.

Genus GONIASTREA Milne Edwards and Haime.

GONIASTREA PECTINATA (Ehrenberg).

1834. *Astrea pectinata* Ehrenberg, Corallenth. Roth. Meer., p. 96.
1879. *Goniastræa pectinata* Klunzinger, Korallth. Roth. Meer., Pt. 3, p. 34, pl. iv, fig. 6.
1904. *Goniastræa pectinata* Gardiner, Madrepor., Maldive and Laccadive Archipel., II, p. 773.

Five specimens of this species were obtained. The calices, wall, septa, pali, and columella have been sufficiently described by Klunzinger and Gardiner, but the corallum has received only scant attention; therefore, I furnish the following notes.

The corallum forms subcylindrical masses with flattish upper surfaces, or is composed of large, truncate, ascending lobes.

The smallest specimen is a short, compressed column, somewhat swollen near its upper end, with a flattened upper surface. Greater diameter of base, 9 cm.; lesser, 7 cm.; height, 7.5 cm.

A second specimen: Greater diameter of base, 8 cm.; lesser, about 7 cm.; height, 11.6 cm. This specimen increases considerably in diameter with upward growth, having a diameter of 10.8 cm. just below its upper end.

Another specimen is 13 cm. tall; diameter of base about 10 cm. In form, it is a somewhat compressed column, with a truncate upper end. The next larger specimen is composed of several truncate lobes. It has a greater basal diameter of 15 cm.; lesser, 6 cm.; height, 13 or 14 cm. Between the lobes the corallum is dead.

The largest specimen is composed of two large lobes, each of which is secondarily lobate, with flattened upper surfaces. Greater diameter of the base, 24 cm.; lesser, 10.5 (the outline of the base is dumb-bell shaped); height, 18 cm.

Klunzinger says, "Ehrenberg's only specimen is convex, 6–8 cm. long and tall." Gardiner gives no information on the growth form of his specimens.

GONIASTREA RETIFORMIS (Lamarck).

1816. *Astrea retiformis* Lamarck, Hist. nat. Anim. sans Vert., II, p. 265.
1879. *Goniastræa retiformis* Klunzinger, Korallth. Roth. Meer., Pt. 3, p. 36, pl. iv, fig. 5.
1904. *Goniastræa retiformis* Gardiner, Madrepor., Maldive and Laccadive Archipel., II, p. 772.

One specimen, which requires no special notice, was obtained.

Genus MÆANDRA Oken.

MÆANDRA PACHYCHILA Ehrenberg.

1834. *Mæandra* (*Platygyra*) *labyrinthica* var. *pachychila* Ehrenberg, Corallenth. Roth. Meer., p. 99.

1879. *Cœloria pachychila* Klunzinger, Korallth. Roth. Meer., Pt. 3, p. 15, pl. 1, fig. 6.

Four specimens were collected.

MÆANDRA LAMELLINA Ehrenberg.

1834. *Mæandra* (*Platygyra*) *lamellina* Ehrenberg, Corallenth. Roth. Meer., p. 99.

1879. *Cœloria arabica* Klunzinger, Korallth. Roth. Meer., Pt. 3, p. 17, pl. 1, figs. 1–3, 8; pl. IX, figs. 10*a*–10*c*.

1902. *Mæandra lamellina* Verrill, Trans. Conn. Acad. Sci., XI, p. 69.

1906. *Mæandra lamellina* v. Marenzeller, Riffkorall. Rot. Meer., p. 55.

A splendid suite of twenty-two specimens of this species was obtained, but Klunzinger has described its variation in so much detail that I can add practically nothing to what he has said.

Genus SCLEROPHYLLIA Klunzinger.

SCLEROPHYLLIA MARGARITICOLA Klunzinger.

1879. *Sclerophyllia margaritícola* Klunzinger, Korallth. Roth. Meer., Pt. 3, p. 4, pl. 1, fig. 12.

This species is represented by three specimens, which, I think, should be described.

Table of measurements.

Specimen.	Diameter of calice.		Height.	Base.
	Greater.	Lesser.[a]		
	mm.	*mm.*	*mm.*	
No. 1	29	25	15	Broad.
No. 2	31	28.5	13	Do.
No. 3	47	41	47	About 15 mm. in diameter.

[a] Measured to outer edges of the septa.

Two of these specimens are young, while the third is apparently adult. Specimen No. 2 corresponds closely with Klunzinger's description and the smaller specimen represented in his figure. The bases of specimens Nos. 1 and 2 of the table are almost as wide as the calices, and are attached to shells and various small objects. Epitheca extends to the edge of the upbending of the wall. Specimen No. 3 is subconical. Its lower portion is badly corroded, and there is no epitheca visible, but it may have been present and have been destroyed through corrosion.

The wall is thick, and has costæ that correspond to all septa and vary in prominence with the size of the corallum. In the large specimen they are very prominent at the calicular edge, but become subobsolete inferiorly; the largest 4.5 mm. tall, and 1.5 mm. thick, with thick, obtuse lobes or spines, that in some instances are 3 mm. long, on

their edges. These largest costæ correspond to the primaries and secondaries; those corresponding to the higher cycles are thin and not so tall.

There are between four and five cycles of septa; in the smaller specimens the primaries are much thickened and there are some thickened secondaries. In the larger, the first two cycles are nearly equal. The septal margins become more exsert with increasing size; in the large specimen the primaries and secondaries project as much as 9 mm. above the edge of the wall; the higher cycles, less exsert. The strong costal spines continue upward on the first two cycles to the summit of the arch. The inner portion of the margins of these septa are without coarse dentations, but possess very small dentations, visible only with a lens. Near the columella there are one or two broad lobes, the margins within these lobes falling almost perpendicularly to the edge of the columella. The inner margins of the members of the higher cycles are dentate, even lacerate. The first three cycles extend to the columella; there is considerable grouping of the higher cycles around the tertiaries. Both the septal and costal faces are minutely granulate and decidedly rough.

The columella is well developed, elliptical in outline, flat above, and composed of a mass of anastomosing, fine trabeculæ. It extends high up in the calice, in places the edge of the wall actually being lower than its upper surface.

Endothecal dissepiments present.

Genus GALAXEA Oken.

GALAXEA, species.

A single specimen of *Galaxea*, attached to the same object, a piece of dead coral overgrown with Serpulia, etc., as two specimens of *Favia savignyi* Milne Edwards and Haime, was collected. The corallum is partly dead and appears to be abnormal. It probably is a stunted and deformed specimen of *Galaxea fascicularis* (Linnæus).

The corallites are unequal in size, elliptical in cross-section. The maximum diameter of a calice, measured between thecal summits, 5.25 mm.; distance between calices from 2 to 4 mm.; height of corallites, measured to top of theca, 4.5 to 6.5 mm.; septal margins exsert, as much as 4 mm. Costæ only slightly developed. In the largest calices there are three complete cycles of septa, with an occasional quaternary.

Without a considerable suite of specimens for comparison, I doubt if this specimen can be identified.

Genus SIDERASTREA de Blainville.

SIDERASTREA SAVIGNYANA (Milne Edwards and Haime).

1857. *Astraea savignyana* MILNE EDWARDS and HAIME, Hist. nat. Corall., II, p. 508.

1879. *Siderastræa savignyana* KLUNZINGER, Korallth. Roth. Meer., Pt. 3, p. 77.

One somewhat depressed head, 15 cm. in diameter and 8.5 cm. thick, was collected. The specimen is typical.

Genus COSCINARÆA Milne-Edwards and Haime.

COSCINARÆA MONILE (Forskål).

Plate XXIII, figs. 1, 2; plate XXIV, figs. 1, 2, 3.

1775. *Madrepora monile* FORSKÅL, Descript. Animal. quae in itin. orient. observ., p. 133.

1878. *Coscinaræa monile* KLUNZINGER, Korallth. Roth. Meer., Pt. 3, p. 79, pl. IX, fig. 4; pl. X, figs, 17*a* and 17*b*.

1890. *Coscinaræa mæandrina* ORTMANN, Zool. Jahrb., L, p. 297.

1906. *Coscinaræa monile* v. MARENZELLER, Riffkorall. Rot. Meer., p. 64, pl. XXIV, fig. 83.

Two specimens, one a young corallum attached to the base of *Siderastrea savignyana*, the other a small head 81 mm. in diameter and 60 mm. thick, were obtained. They agree precisely with the descriptions and figures of Klunzinger and von Marenzeller, the latter of whom has redescribed and figured Forskål's type.

As I think new figures desirable, they are herewith presented.

Genus FUNGIA Lamarck.

I have followed Professor Döderlein's Die Korallengattung Fungia in determining these species. Reference is made only to his memoir.

FUNGIA (CYCLOSERIS) PATELLA (Ellis and Solender).

1902. *Fungia patella* DÖDERLEIN, Korallengat. Fungia, p. 65, pls. I, II; pl. V, figs. 1, 2.

Twelve specimens.

FUNGIA (CYCLOSERIS) CYCLOLITES (Lamarck.)

1902. *Fungia cyclolites* DÖDERLEIN, Korallengat. Fungia, p. 77, pl. IV, figs. 7–9; pl. V. figs. 5, 5*a*.

One specimen.

FUNGIA PLANA Studer.

1902. *Fungia plana* DÖDERLEIN, Korallengat. Fungia, p. 111, pl. XI, figs. 2–5.

Eleven specimens.

Several of these specimens show interesting variation. Six of them are actually, or almost, typical *F. plana;* in four the costæ are decidedly thin, and those intermediate between the tall ones have finely dentate edges; the intermediate costæ of one specimen are to

the naked eye entire, but a lens reveals microscopic dentations. The specimens evidently are a connected series. They have suggested to me that Döderlein's *F. klunzingeri* may prove to be a variation of *F. plana*. This, however, must be taken merely as a suggestion, and not as an opinion, for the specimens studied do not warrant a conclusion.

FUNGIA CONCINNA Verrill.

1902. *Fungia concinna* Döderlein, Korallengat. Fungia, p. 113, pl. xii, figs. 1–3; pl. xiii, fig. 4.

Three specimens, furnishing the following measurements:

Specimen.	In plane of oral axis.	Transverse to oral axis.	Height.
	mm.	*mm.*	*mm.*
No. 1	119	115	79
No. 2	110	107.5	36
No. 3	91.5	98	48

The bases are concave, in No. 1, 49 mm. deep; in No. 2, 18.5 mm.; in No. 3, 28.5 mm.

These specimens have puzzled me exceedingly. As the smaller costæ are without spines, they appear to belong to the *F. danai* group; microscopic costal dentations and granulations, however, are present, making it most probable that they should group with *F. repanda*. The corallum base is imperforate; principal costæ and those next in size, thin, prominent, with slender, irregularly shaped, rough spines. Septa thin, unequal, with coarse, irregular dentations, 3 to 10 to the centimeter. Upper dental margins usually truncate; incisions between the teeth acute. The specimens are not typical, but I believe they must be referred to Verrill's *F. concinna*.

FUNGIA FUNGITES (Linnæus).

1902. *Fungia fungites* Döderlein, Korallengat. Fungia, p. 136, pls. xx–xxv.

Sixteen specimens.

Two variations are represented: 1. Corallum thin, near the margin 9 mm.; costæ thin, with small spines; septal margins finely dentate. 2. Corallum thicker, near the margin 16.5 mm.; costæ thicker with coarser spines; septal margins coarsely dentate. In the first form, the corallum is flat; in the second, arched above, with a concave base. The two forms represent the extremes of the series, a more detailed description seems superfluous.

FUNGIA ECHINATA (Pallas).

1902. *Fungia echinata* Döderlein, Korallengat. Fungia, p. 101, pl. x, figs. 1–5.

Two specimens.

Genus HERPETOLITHA Eschscholtz.

HERPETOLITHA FOLIOSA (Ehrenberg).

1879. *Herpetolitha foliosa* KLUNZINGER, Korallth. Roth. Meer., Pt. 3, p. 68, pl. VIII, figs. 4, 5.

Six specimens, four of which show distinct detachment scars. I have already called attention to this phenomenon in my Critical Review of the Literature on the Simple Genera of the Madreporaria Fungidæ, with a Tentative Classification.[a]

Genus ASTREOPORA de Blainville.

ASTREOPORA EHRENBERGII Bernard.

1896. *Astræopora ehrenbergii* BERNARD, The Genus Astræopora, Brit. Mus. Cat. Madrepor., II, p. 92, pl. XXXIII, fig. 15.

One specimen.

Genus GONIOPORA Quoy and Gaimard.

GONIOPORA SOMALIENSIS, new species.

Plate XXV; plate XXVII, fig. 1.

Corallum forming an undulated lamina attached by a portion of one side, the free edge broadly lobate. Extreme width, 89 mm.; width in sinus between lobes, 35 mm.; width along lobe, 62 mm.; greatest thickness, 10 mm. The margin is acute or obtusely rounded. The upper surface covered with calices; the lower, invested to the margin by a minutely, concentrically striate epitheca.

Calices of moderate size, from 2.5 to 4.5 mm. in diameter, usually about 3.5 mm.; polygonal, very shallow or superficial. Walls thin, poorly developed, reinforced by peripherally disposed synapticula.

Septal formula complete, that is, twenty-four in number, with typical gonioporid arrangement. Pali present before the primaries and secondaries, rather irregular in development; moderately prominent, consisting of separate granules, or those before a triplet and the primary joining its inner end, fused laterally. Usually there are two rough dentations between a palus and the mural denticle. Interseptal loculi narrow but open. The columella tangle extends outward beyond the pali; it is large, often with a tendency to compactness.

Type.—One specimen, one piece of which is in the Muséum d'Histoire Naturelle, Paris, the other in the United States National Museum.

Remarks.—Bernard, in his work on *Goniopora*, describes three forms that are similar to the one under discussion, namely: G. Barrier Reef (12) 1; G. North-West Australia (6) 2; G. North-West Australia (6) 3. The last one seems the nearest; it differs by having a closely encrust-

[a] Proc. U. S. Nat. Mus., XXVIII, 1905, p. 380, footnote.

ing corallum. As Bernard attaches no specific names to the forms described by him, the one here proposed will stand, even if it should be synonymous with one of his.

GONIOPORA DJIBOUTIENSIS, new species.

Plate XXVI; Plate XXVII, fig. 2.

Corallum rounded on the upper surface, transverse outline irregular, somewhat reniform; corallites rising from a small base, diverging upward, new corallites appearing in the angle between the older ones. The basal portion through a distance of from 44 to about 75 mm., depending upon where measured, is dead, and the epitheca, should it once have been present, has been eroded away. The edge of the living portion in places slightly projects downward over the dead portion, in other places it is flush with the dead. The projecting living edge is supported by epitheca; that part of the living portion flush with the dead is margined by epitheca. The epitheca is irregularly and finely wrinkled.

Dimensions of the corallum: Height, 104 mm.; greater transverse diameter, 131 mm.; lesser, 29 to 75 mm.

Calices subpolygonal or circular in outline; shallow, superficial to 1.5 mm. deep; fully grown ones, 5 to 5.5 mm. in diameter. The walls have a rough upper surface, about 1 mm. across, formed by the outer ends of septa.

Septal formula complete, 24 septa, with the typical gonioporid arrangement. Interseptal loculi open, in width equaling or slightly exceeding the thickness of the septa. Septal faces roughly granulate; margins with several dentations corresponding to inwardly inclined, ascending trabeculæ. About six pali in the superficial calices; indistinct or absent in the deeper ones.

Columella fangle large, more than half the diameter of the calice, extending outward to the inner ends of the tertiary septa; composed of concentrically arranged synapticula and fused inner ends of the septa; upper surface roughly spinulose.

Type.—Muséum d'Histoire Naturelle, Paris; a piece in the United States National Museum.

GONIOPORA STOKESI Milne-Edwards and Haime.

Plate XXVIII, figs. 1, 2.

1860. *Goniopora stokesi* Milne Edwards, Hist. nat. Corall., III, p. 192.

Corallum forming masses that are hemispherical or domed above; base epithecate, flat, concentrically corrugated, concave, or, in the largest specimen obtained, truncate and inversely conical. The living portion is hemispherical or domed.

Table of measurements.

Specimen.	Base.		Corallum.		
	Diameter.		Diameter.		Height.
	Greater.	Lesser.	Greater.	Lesser.	
	mm.	*mm.*	*mm.*	*mm.*	*mm.*
No. 1	60.5	58	61	59	31
No. 2	49	46	59	59	59
No. 3	53	53	65	58	51
No. 4	83	78	92	87	64
No. 5[a]	128	115	147	134	168

[a] Base truncate, inversely conical, 97 mm. tall.

The young corallum is small, later corallites appearing in the angles between the older, the peripherally placed ones bending outward from the vertical axis.

Calices polygonal or subcircular in outline; decidedly deep, from 2.5 to 5 mm. or slightly more, shallower near the periphery, deeper on the top. Diameter on smaller specimens about 5 mm., on the largest 7 mm. Walls tall, range in thickness from dividing membranes to 1.25 mm., the septa continue upward to the summit as ridges, and have numerous perforations between them. The corners between the calices thickened.

The septal formula complete, 24 septa, with the typical gonioporid arrangement. Interseptal loculi open, wider than the thickness of the septa, short, because of the great development of the columella tangle. Septal faces granulate, but not strikingly rough. There are no distinctly developed pali.

Columella tangle greatly developed, in some instances almost filling the corallite cavity, composed of centrically arranged synapticula and interlacing septal ends, upper surface flattish or somewhat domed, with fine spinulations.

Remarks.—This coral should be compared with Bernard's *Goniopora* Java Sea (4) 1 and *Goniopora* xa.

GONIOPORA PLANULATA (Ehrenberg).

1834. *Astræa planulata* Ehrenberg, Corallenth. Roth. Meer., p. 95.

1879. *Goniopora planulata* Klunzinger, Korallth. Roth. Meer., Pt. 2, p. 45, pl. viii, fig. 23; pl. v, fig. 24.

1903. *Goniopora Red Sea (6) 1* Bernard, Genus Goniopora, Brit. Mus. Cat. Madrepor., IV, p. 100, pl. viii, figs. 1, 2; pl. xiii, fig. 12.

It is unnecessary to redescribe this species, as it has been so fully considered by Klunzinger and Bernard. Doctor Gravier obtained two specimens, one a young corallum, the other large and composed of three incrassate lobes.

EXPLANATION OF PLATES.

PLATE XVII.

Physogyra somaliensis, new species, natural size ..... p. 250

PLATE XVIII.

Physogyra gravieri, new species ..... p. 251

FIG. 1. Upper surface of corallum, natural size.
2. Tangential section, showing septa and dissepiments, x 4.

PLATE XIX.

Cyphastrea forskaliana (Milne Edwards and Haime), natural size ..... p. 253

PLATE XX.

Fig. 1. Calices of *Cyphastrea forskaliana* (Milne Edwards and Haime) x 4 ..... p. 253
2. Calices of *Cyphastrea forskaliana* (Milne Edwards and Haime), x 4 ..... p. 254
3. Calices of *Orbicella annuligera* (Milne Edwards and Haime), x 4 ..... p. 252

PLATE XXI.

Orbicella annuligera (Milne Edwards and Haime), natural size ..... p. 252

PLATE XXII.

FIG. 1. *Cyphastrea forskaliana* (Milne Edwards and Haime), natural size ..... p. 254
2. *Cyphastrea forskaliana* (Milne Edwards and Haime), longitudinal section of corallites, x 4 ..... p. 253
3. *Cyphastrea forskaliana* (Milne Edwards and Haime), longitudinal section of corallites, x 4 ..... p. 254
4. *Orbicella annuligera* (Milne Edwards and Haime), longitudinal section of corallites, x 4 ..... p. 252

PLATE XXIII.

Coscinarœa monile (Forskål) ..... p. 260

FIG. 1. Corallum, natural size.
2. Calices, x 5.

PLATE XXIV.

Coscinarœa monile (Forskål) ..... p. 260

All figures, x 4.

FIG. 1. Tangential section of corallite, showing synapticula.
2. Cross section of corallites.
3. Face of septum, showing trabeculæ, perforations, and dissepiments.

PLATE XXV.

Goniopora somaliensis, new species, natural size ..... p. 262

PLATE XXVI.

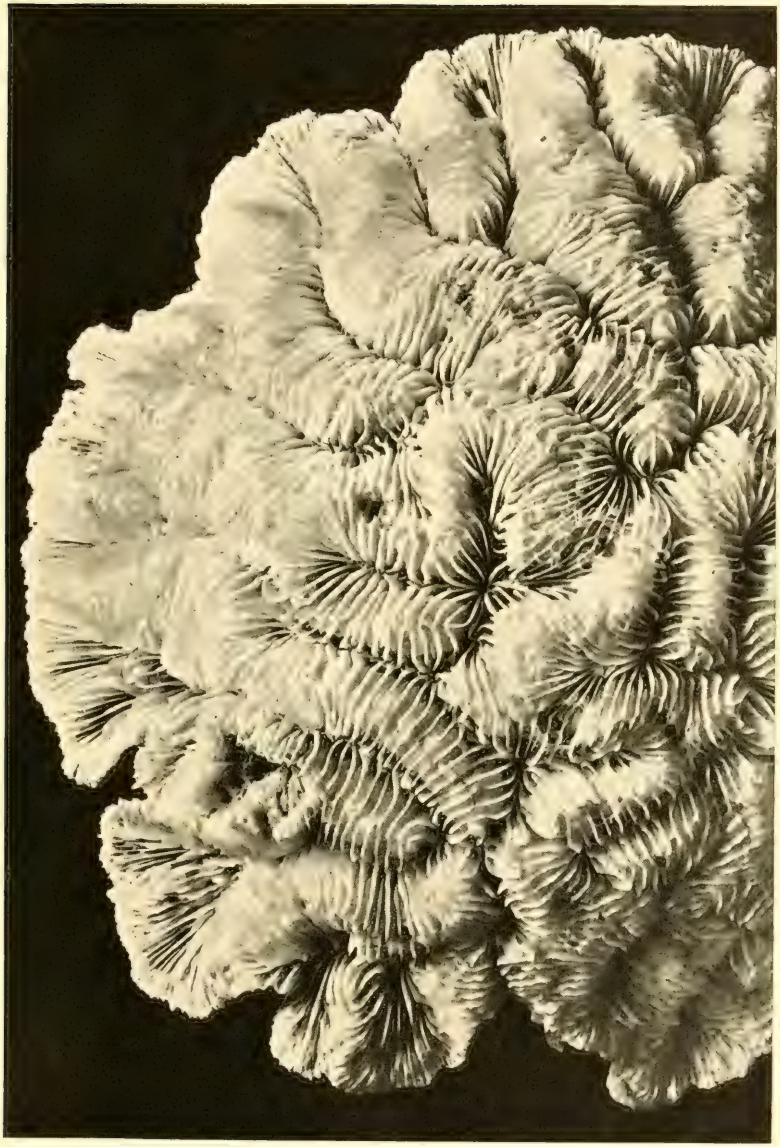
Goniopora djiboutiensis, new species, natural size ..... p. 263

PLATE XXVII.

FIG. 1. *Goniopora somalieinss*, new species, calices, x 4..... p. 262
2. *Goniopora djiboutiensis*, new species, calices, x 4..... p. 263

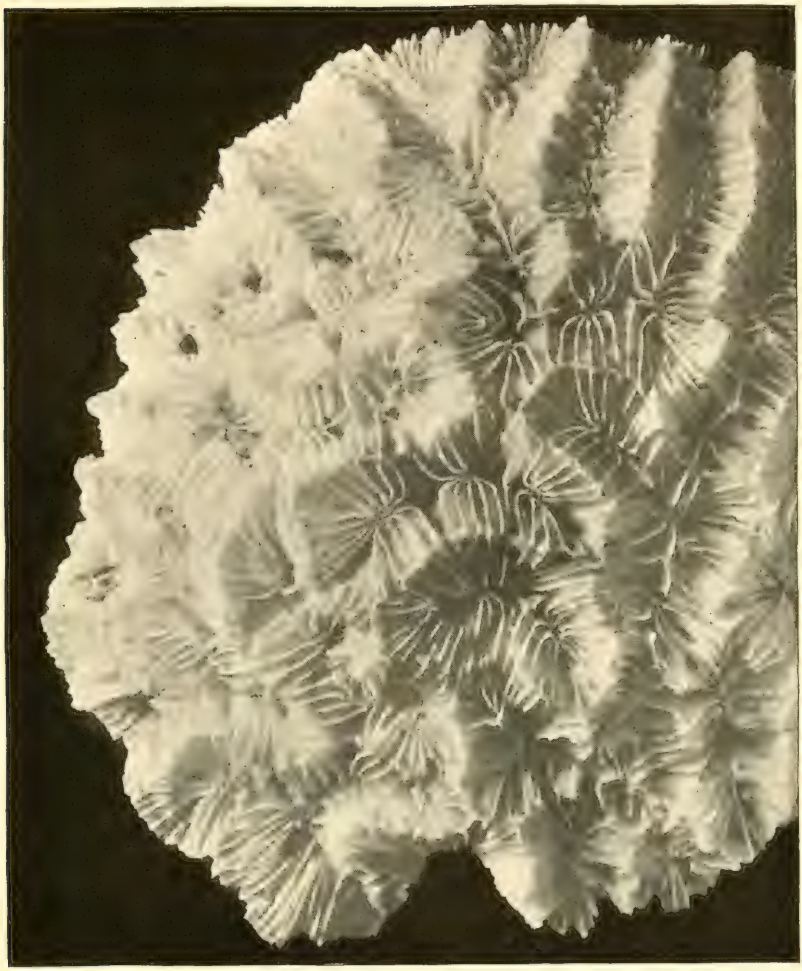
PLATE XXVIII.

FIG. 1. Corallum, of *Goniopora stokesi* (Milne Edwards and Haime), natural size. p. 263
2. Calices, x 4.

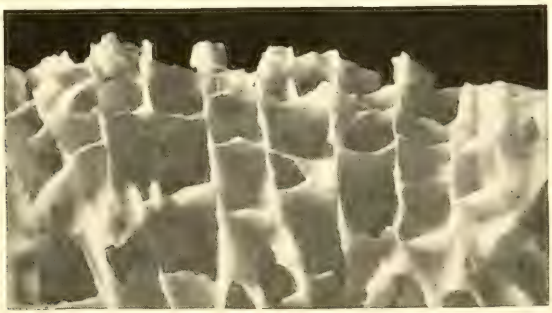


EAST AFRICAN CORALS.

FOR EXPLANATION OF PLATE SEE PAGE 265.



1



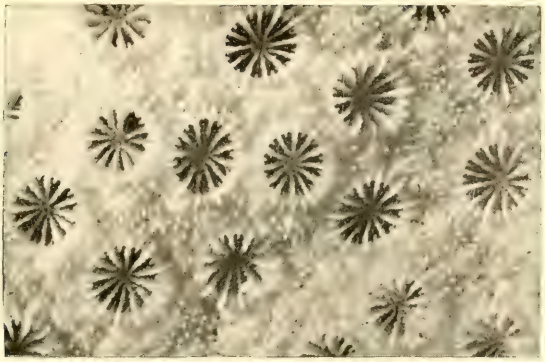
2

EAST AFRICAN CORALS.

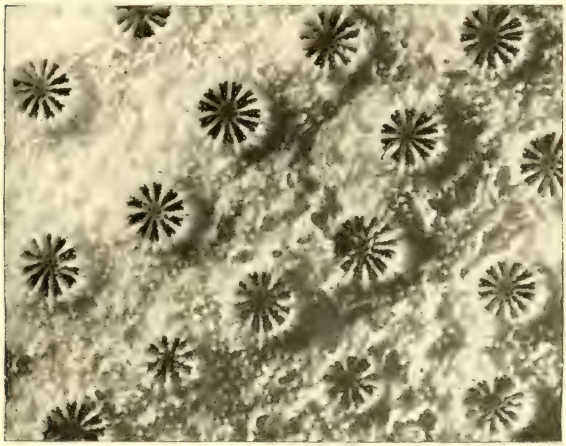
FOR EXPLANATION OF PLATE SEE PAGE 265.

EAST AFRICAN CORALS.

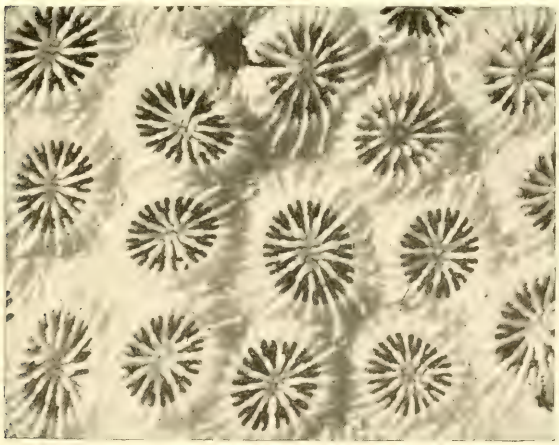
FOR EXPLANATION OF PLATE SEE PAGE 265.



1



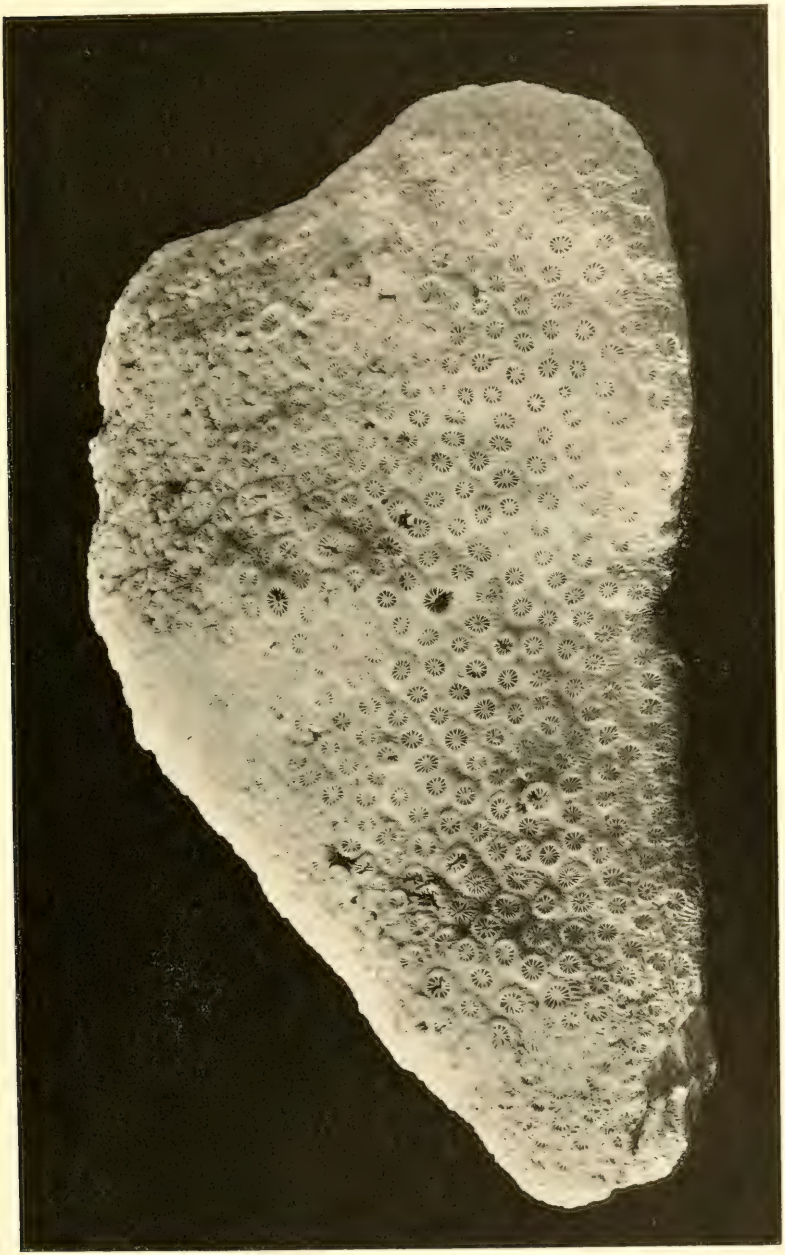
2



3

EAST AFRICAN CORALS.

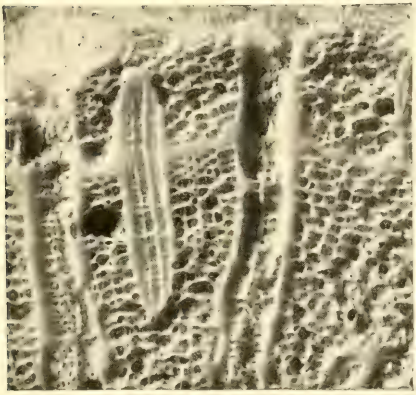
FOR EXPLANATION OF PLATE SEE PAGE 265.



EAST AFRICAN CORALS.

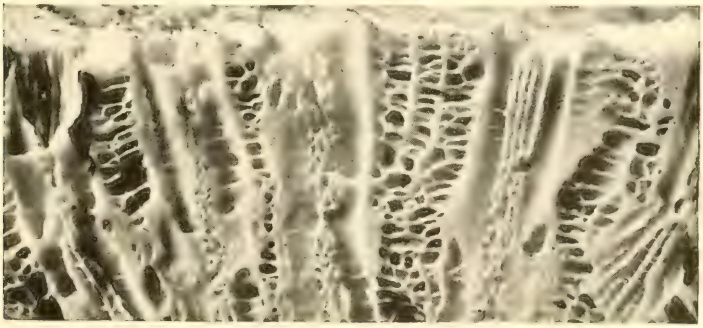
FOR EXPLANATION OF PLATE SEE PAGE 265.

1



2

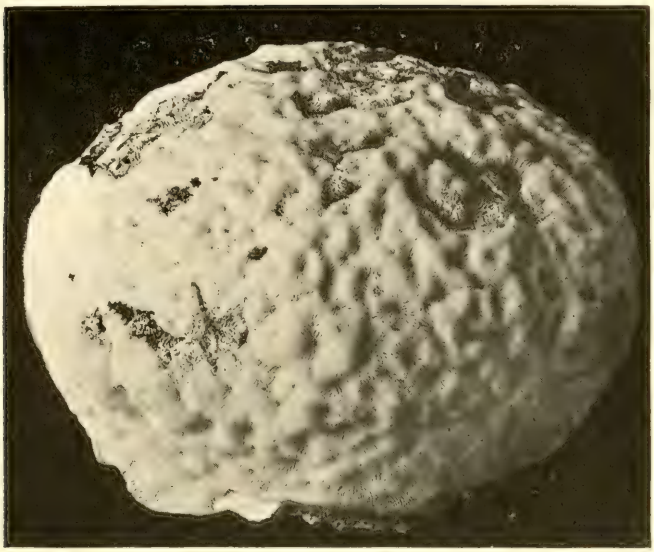
3



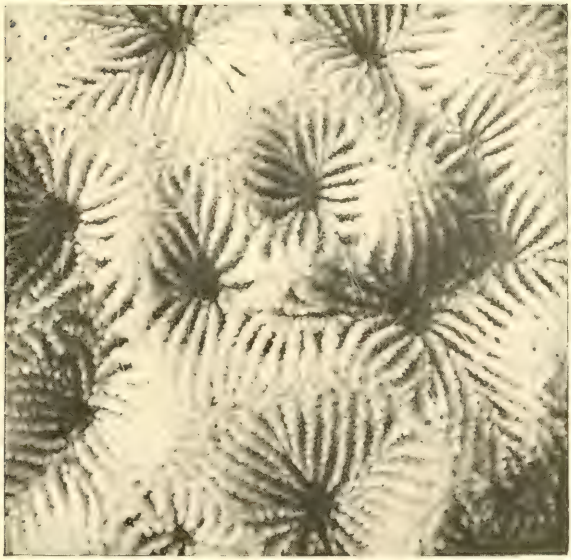
4

EAST AFRICAN CORALS.

FOR EXPLANATION OF PLATE SEE PAGE 265.



1

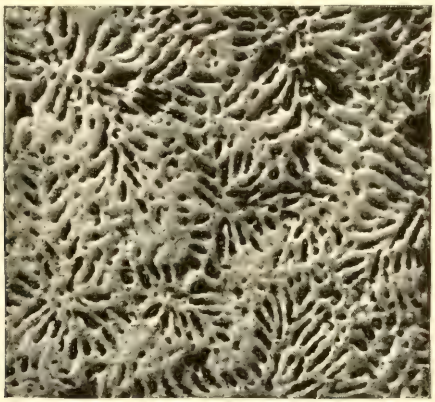


2

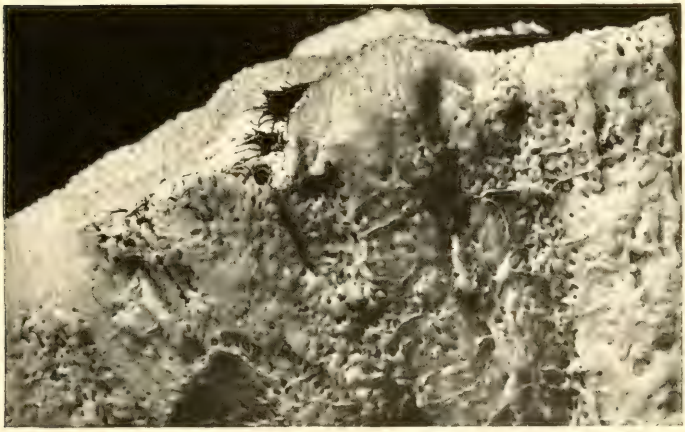
EAST AFRICAN CORALS.

FOR EXPLANATION OF PLATE SEE PAGE 265.

1



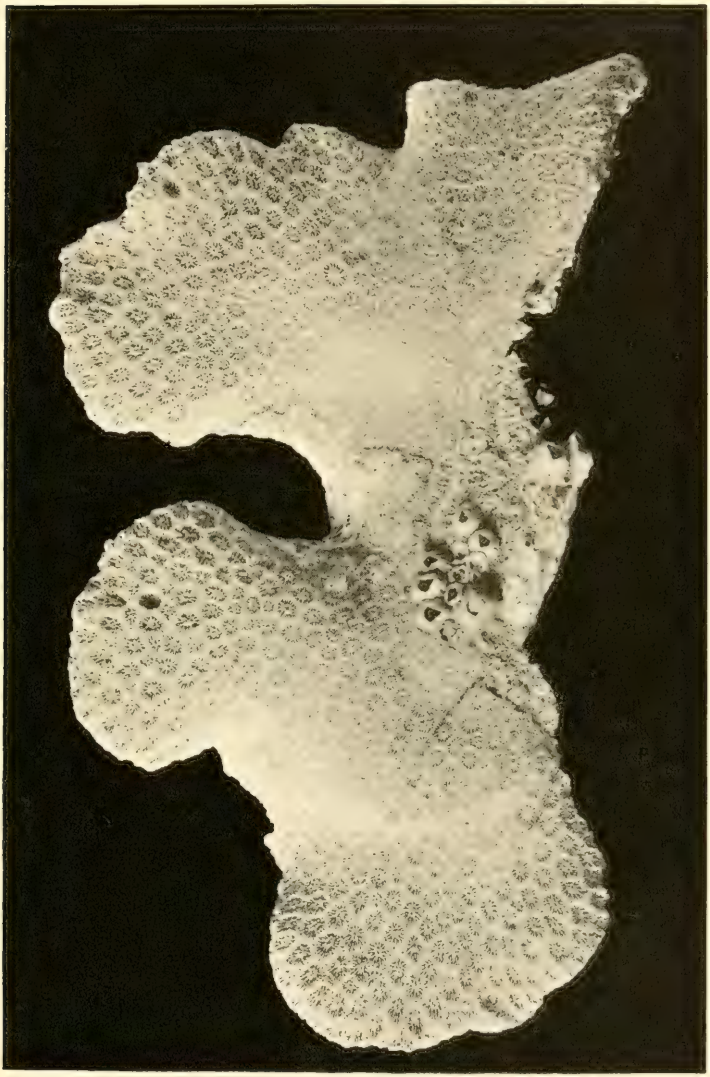
2



3

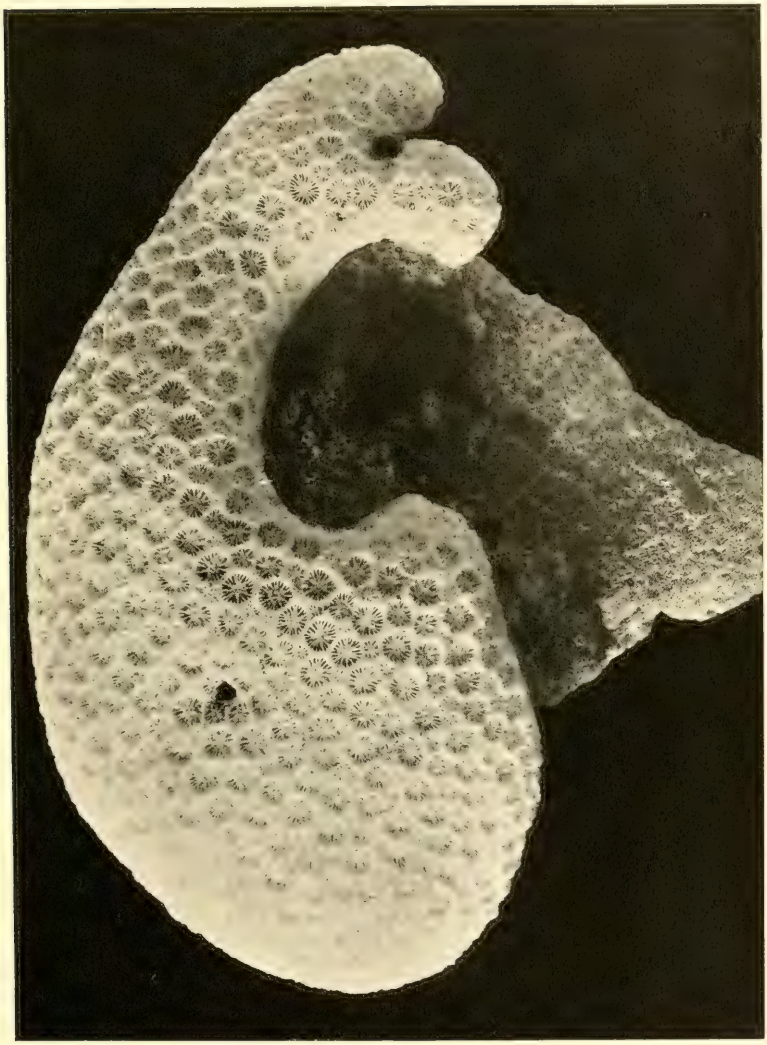
EAST AFRICAN CORALS.

FOR EXPLANATION OF PLATE SEE PAGE 265.



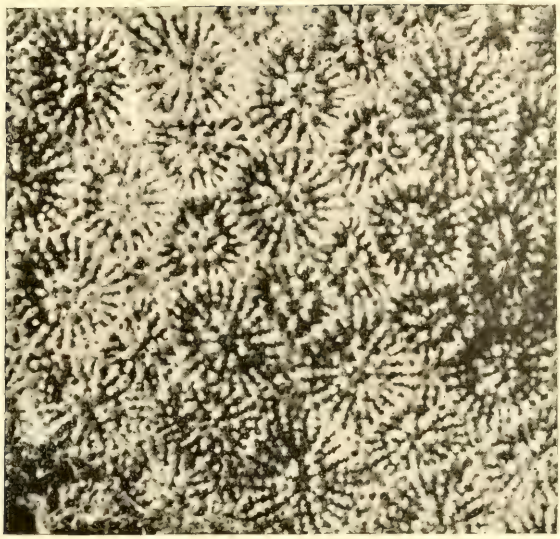
EAST AFRICAN CORALS.

FOR EXPLANATION OF PLATE SEE PAGE 265.

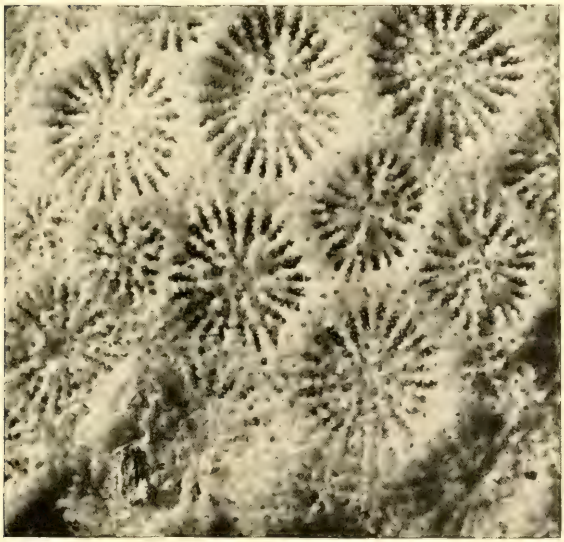


EAST AFRICAN-CORALS.

FOR EXPLANATION OF PLATE SEE PAGE 265.



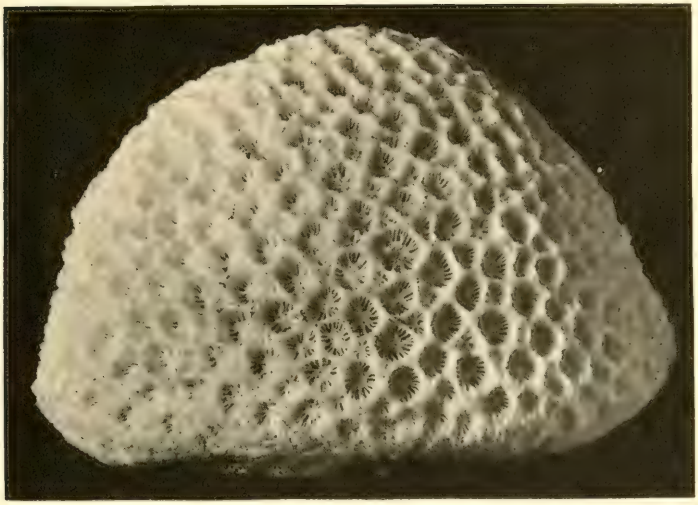
1



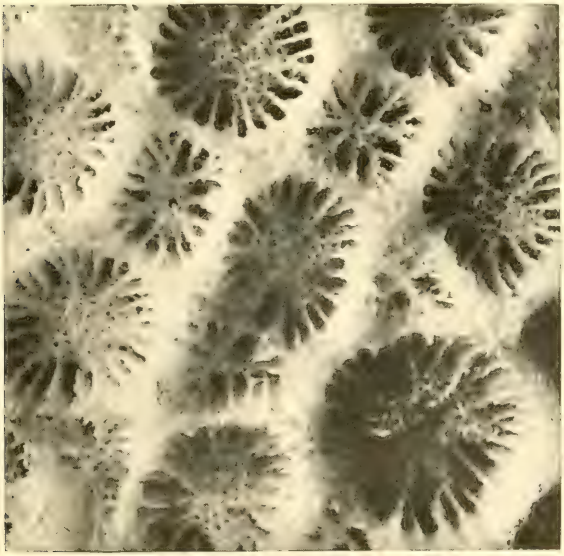
2

EAST AFRICAN CORALS.

FOR EXPLANATION OF PLATE SEE PAGE 266.



1



2

EAST AFRICAN CORALS.

FOR EXPLANATION OF PLATE SEE PAGE 266.

A NEW BRACHIOPOD, RENSSELAERIA MAINENSIS, FROM THE DEVONIAN OF MAINE.

By Henry Shaler Williams,

Of Cornell University, Ithaca, New York.

In the discussion of the fauna of the Chapman sandstone of Presque Isle Brook, Edmunds Hill, and other localities in Chapman County, Maine, I referred to one of the most conspicuous and common fossils of the fauna under the name "*Rensselaeria* (*Beachia*) n. s., cf. *B. suessana*," and there made the following remark:

> The abundant and great development of the *Rensselaeria* is a notable feature of the fauna. The specimens are provisionally referred to *R. suessana*, which they most nearly approach among the American forms in generic characters. Comparisons with the figures of *Terebratula trigiceps*, referred by Keyser and others to *Rensselaeria*, as well as study of the faunal associates, leads me to the opinion that the Maine specimens may be identical with the European forms. The name *Rensselaeria mainensis* is provisionally proposed for the form.[a]

As the material was further studied and illustrations of it were being prepared, the expectation was strong that the species would prove to be only an extreme variety, due to shell thickening of a species such as *R.* (*B.*) *suessana* or *R.* (*B.*) *ovalis*. Comparison has, however, brought to light no described species to which it may be referred, and its specific characters I now believe will stand. The shell is thick and massive and in its general form it resembles *Rensselaeria* (*Beachia*) *suessana*. It is much developed at the beak of the pedicle valve; the shell substance of the umbonal region of the pedicle valve is greatly thickened, and the cardinal margin is raised and produced into a distinct flattened pseudo-area in the plane of the edge of the valves. If it were not for the fact that the genus *Rensselaeria*, occasionally, has a distinct flattening of the area which is clearly represented in some figured specimens and is shown on plates of the several species, a new genus might be erected for this character. In the revised description of *Rensselaeria* and of the subgenus *Beachia*, Hall and Clarke distinctly refer to this feature. In the description

[a] Contribution to the Geology of Maine, Williams and Gregory, U. S. Geol. Survey Bull. No. 65, 1900, p. 80.

of the former genus we find "beneath and on each side of the beak is a concave, sharply defined space, but no proper cardinal area." In the description of *Bucchia* it is stated that: "The cardinal margin beneath the beak is flattened into a well-defined pseudo-area."[a] In the specimens before us there is a distinct flattened cardinal area the presence of which is the natural consequence of the great thickening and elevation of the beak portion of that valve. To the writer this difference is not of more than specific rank; the younger forms present only a trace of the areal flattening. In the following description of the species this character is therefore regarded as one of the specific marks of the Maine specimens consequent upon the extreme thickening of the shell.

The accompanying figures represent the molds of the interior of a pedicle and brachial valve of full size, as they appear in the rocks of Chapman Township, Aroostook County, Maine.

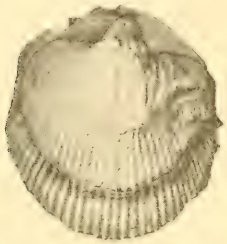


FIG. 1.—RENSSELAERIA MAINENSIS, MOLD OF INTERIOR OF PEDICLE VALVE. NAT. SIZE.

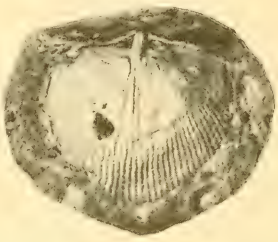


FIG. 2.—RENSSELAERIA MAINENSIS, MOLD OF INTERIOR BRACHIAL VALVE. NAT. SIZE.

RENSSELAERIA MAINENSIS, new species.

A medium-sized rensselaeroid form of the shorter ovate type approaching *R. suessana* in contour, but greatly developed at the umbonal end of the pedicle valve. The beak of the pedicle valve is lengthened and somewhat pointed, as in *R. mutabilis;* it is elevated above the beak of the brachial valve by a high pseudo-cardinal area, in which is a triangular delthyrium, open in all specimens preserved. The edges of the delthyrium are bordered by a narrow flattened margin which may be the support of the original deltidial plate or plates, which are wanting in all specimens preserved. These flattened margins of the delthyrium meet at the apex of the delthyrium below the circular foramen, which is nearly terminal.

The greatest width of the shell is at about one-third distance from the beaks. The average size of mature shells is about one inch in length and a little less in greatest width.

The pedicle valve is ventricose and in some of the larger shells near the beak is half an inch in depth. The brachial valve is convex and evenly rounded, about one-half as deep as the opposite valve; neither valve shows any median depression or furrow. The beak of the pedi-

[a] Thirteenth Ann. Rept. State Geologist, New York, 1894. pp. 849 and 850.

cle valve extends upward with only slight inward curvature directly above the cardinal area, which lies nearly in the plane of the margin of the shells, the tip of the beak slightly overarching the pseudo-area. The angle formed by the sides of the beak is from 120° to 140°.

The surface ornamentation is made up of strong linear striæ, of which 45 to 75 can be counted, consisting of rounded thread-like ridges separated by rounded grooves, giving the surface a striate appearance somewhat coarser than that of normal *R. ovoides*.

The musculature is strong in well-preserved specimens and corresponds very closely to that of *Beachia suessana* for both the pedicle and brachial valves. The crural bases are two widely separated, strong, round bars in the molds leaving two well-defined holes each side of the base of the cardinal process. No evidence of the shape of the brachial supports is present. The shell structure appears to be fibrous; no punctæ have been discovered. The visceral foramen is indicated.

The molds of the interior differ greatly, according to the age and strengthening of the shell, especially the pedicle valve. In the younger shells the dental lamellæ are thin and separate two lateral cavities from the central muscular cavity. The lateral cavities reach nearly to the hinge margin. As the umbonal cavity of the shell becomes filled, by thickening of the shell substance, the central muscular cavity between the hinge plates is represented in the mold by a rounded ridge bounded by the dental lamellæ, the lateral cavities being completely filled by shell deposit. This rounded ridge, extending beakward from the main mass of the internal filling of the shell in the molds, increases in width with the elevating of the pseudo-area. In extreme examples the shell deposit is fully one-fourth inch in thickness, thus giving to the interior markings of the shells great difference of form, according to the age of the shell.

Type.—The two specimens figured are designated as cotypes of the species. They are now in the collection of the U. S. Geological Survey, with the other material on which the description is based, and will be transferred to the U. S. National Museum.

The species is abundant in the shales and sandstones of the Chapman formation of Presque Isle Brook and Edmunds Hill in Chapman Township, Aroostook County, Maine.

A NEW FOSSIL STICKLEBACK FISH FROM NEVADA.

By Oliver P. Hay,

Of the American Museum of Natural History, New York city.

The writer has received from the Geological Department of the U. S. National Museum for description four specimens of small fossil sticklebacks that were collected by Mr. Thomas H. Means from the Lahontan beds, through which the Truckee irrigation canal was being cut, three miles southwest of Hazen, Nevada. These fishes are inclosed in a very white clay which splits readily into thin laminæ.

All the specimens belong to a single species, and this is a member of the genus *Gasterosteus*, a genus containing a number of small spiny-rayed fishes known as sticklebacks. These inhabit the salt and brackish waters of the coasts, as well as some of the fresh-waters, of Europe and North America. One species, *G. cataphractus*, is found along the Pacific coast from San Francisco to Alaska. Another, *G. williamsoni*, occupies fresh-water streams in the interior of southern California. A subspecies of this form, *G. williamsoni microcephalus*, inhabits streams and brackish waters along the coast from Alaska to Lower California.

The facts regarding the sticklebacks of the Pacific region are obtained from Jordan and Evermann's Fishes of North and Middle America.

The fishes sent me are closely related to all the species just mentioned; also to *G. bispinosus*, of eastern America, and to *G. aculeatus*, of Europe. The fossils, however, present characters of subspecific value.

GASTEROSTEUS WILLIAMSONI LEPTOSOMUS, new subspecies.

The first of the specimens (Cat. No. 5386, U.S.N.M.), the type, displays the nearly complete skeleton (fig. 1). Most of the important bones of the head can be identified. The mouth gapes and displays traces of teeth. The anterior dorsal spine is missing; the second and third are represented by impressions in the clay. The dorsal soft rays are disturbed and some are missing. The pectoral fin is preserved and

the rays are 10 mm. long. The ventral fins are gone, but a portion of the ventral plate is present. Its outer surface was sculptured. The anal fin is disturbed and a part missing. The caudal is preserved. The length of the fish from the snout to the base of the caudal is 51 mm.; the length of the head, 14.5 mm.; the depth of the body, 9.5 mm. There is no trace of either lateral armor or a caudal keel.

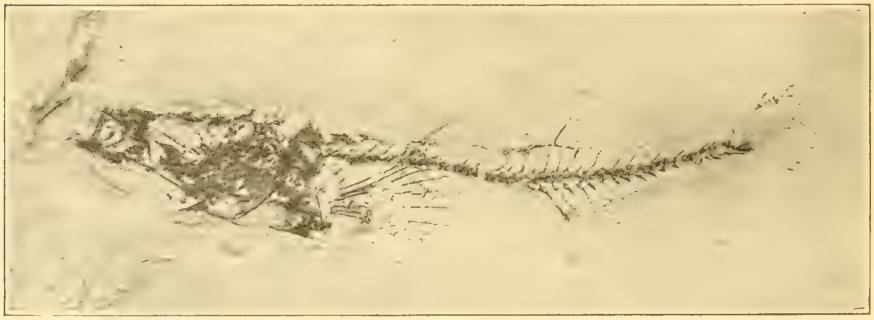


FIG. 1.—SKELETON OF GASTEROSTEUS WILLIAMSONI LEPTOSOMUS. (TYPE) ×1½.

The second (Cat. No. 5387, U.S.N.M.) lacks most of the head (fig. 2). The length from the shoulder girdle to the base of the caudal is 38.5 mm.; the depth is 10 mm. The first dorsal spine is 3 mm. long; the second 5 mm.; the third is short and curved. There are 10 soft dorsal rays. The ventral spines have a length of 7 mm. and the ventral plates a length of 11 mm. The anal spine is short and curved, and there are counted 9 soft rays, with an interhaemal spine for a tenth.

FIG. 2.—NEARLY COMPLETE SKELETON OF GASTEROSTEUS WILLIAMSONI LEPTOSOMUS. ×1½.

Below and in front of the second dorsal spine are remains of three plates belonging to the lateral armor, but there is no indication of the caudal keel.

The third (Cat. No. 5388, U.S.N.M.) presents the head, the second dorsal spine, and a portion of the ventral plate. The spine is 4 mm. long. The ascending process of the ventral plate is sculptured.

The fourth (Cat. No. 5389, U.S.N.M.) furnishes the body behind the fronts of the dorsal and anal fins (fig. 3). Only 8 soft rays appear in the dorsal and anal fins; but evidently at least one in each is missing.

The slenderness of the body (depth in the length 5 times) differentiates this fish from all the others except *G. bispinosus*, in which the depth is 5.5. In all the others the depth does not go above 4 times in the length. From the species *G. bispinosus* and its subspecies *curiari* our fossil differs in the fin formula, that of *G. spinosus* being D. II, I, 12; A. I, 8.

It is evident that the Lahontan fishes are most closely related to the typical form of *G. williamsoni*, the species now living within a few hundred miles of the Lahontan beds. The fin formula of this species differs only in having 8 soft anal rays. However, the body of the fossil form is slenderer, the second dorsal spine is longer, entering the distance from the snout to the pupil once, instead of 1.5 to 2 times. The first dorsal spine of the fossil appears to be much shorter than in the living species considered. The ventral spines seem to be longer than

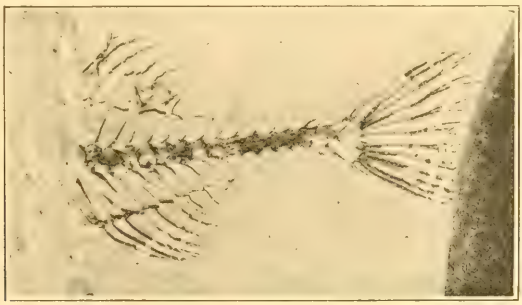


FIG. 3.—POSTERIOR PORTIONS OF SKELETON OF GASTEROSTEUS WILLIAMSONI LEPTOSOMUS. ×1½.

in *G. williamsoni*, and the ventral plates are considerably longer than the snout and the orbit taken together; the snout and orbit being 7 mm. long, the plates 11 mm.

From *G. williamsoni microcephalus* the fossil form is distinguished by several characters besides the slenderer body. There are more rays in the anal fin and the ventral plates are longer.

In the typical form of *G. williamsoni* it is only in occasional individuals that the lateral armor is found, and in these only 2 or 3 plates appear on each side. In *microcephalus* there are usually 5 or 6 plates; but there may be as many as 26. On the other hand, individuals are sometimes found that are wholly devoid of lateral armor.

The presence of this fossil stickleback in the Lahontan beds, related as it is to *G. williamsoni*, appears to indicate an age not older than Quaternary, and that the beds were deposited in fresh rather than in salt or brackish water.

Excepting a specimen supposed to belong to *G. bispinosus*, found in the Pleistocene of Canada by Sir William Dawson, no fossil stickleback has hitherto been reported.

NOTES ON CALYPTROBOTHRIUM, A CESTODE GENUS FOUND IN THE TORPEDO.

By Edwin Linton.

Of Washington and Jefferson College, Washington, Pennsylvania.

The genus *Calyptrobothrium*, established by Monticelli[a] belongs to the family Tetrabothriidæ and is near the genus *Monorygma*.

The scolex is provided with four flexible unarmed bothria and each bothrium with a single large horseshoe-shaped sucker.

In 1899[b] I described a species of *Calyptrobothrium* under the name *C. occidentale*. This description was based on one large and eight small specimens collected from the torpedo (*Tetranarce occidentalis*). No mature segments were found, and, although the large specimen was regarded by me at the time of collecting as a different species from the small specimens, a study of the preserved material did not appear to justify placing them in distinct species.

During the summer of 1905, I had the opportunity of examining a considerable number of these cestodes, and, finding the two kinds, in some cases associated together, in others separate, moreover with ripe segments, which were proved to belong to the small variety, it became evident that the two sizes represented different species.

The name *Calyptrobothrium occidentale* is retained for the larger variety of the original description and the name *C. minus* is proposed for the smaller variety.

The following account is based on material collected at the laboratory of the Bureau of Fisheries, Woods Hole, Massachussetts, in July and August, 1905. The torpedoes were taken at Menemsha Bight, Vineyard Sound. Some of them were brought to Woods Hole alive; others were opened when taken and the viscera placed in formalin.

[a] Naturalista Siciliano, An. xii, 1893, p. 15 of Author's separate, pl. 1, figs. 1-4.

[b] Bull. U. S. Fish. Comm. for 1899, p. 298.

Summary of collections made in 1905.

Date.	Number of hosts.	Condition of material.	*C. occidentale.*	*C. minus.*	Food notes.
July 21	1	In formalin			Empty.
July 27	1	do		100	Pebbles.
August 4	1	Living		Many.	Empty.
August 7	1	do	7	55	Do.
August 8	1	In formalin	2		Do.
August 9	1	Living		20	Do.
August 10	1	In formalin	2	Few.	Do.
August 12	2	Living	Few in one host only.	12 in each.	Amphipod and otolith of squeteague.
August 17	1	In formalin		17	Empty.
August 18	1	do	Few.	Few.	Do.
August 18	1	do	4	8	Otoliths of fish.
August 19	1	do	1		Empty.
August 22	1	do	Few.	Few.	Do.
August 26	1	Living		8	Do.

CALYPTROBOTHRIUM OCCIDENTALE Linton.

Calyptrobothrium occidentale LINTON, (part) Bull. U. S. Fish Comm. 1899, pp. 298–299, pl. XLI, figs. 94, 95, 97.

Head with thickened axial portion, bluntly rounded in front; bothria four, in pairs, the anterior end of each a relatively large horseshoe-shaped sucker, and sessile, the posterior end auriculate and free. Neck continuous with axial portion of head, retaining dimensions of head, exclusive of bothria, for a short distance, then diminishing slightly. Entire strobile nearly linear; segments begin remote from head, at first much shorter than broad, later becoming squarish, finally nearly circular and separating easily; free segments usually a little longer than broad, with rounded extremities; none certainly seen with ripe ova.

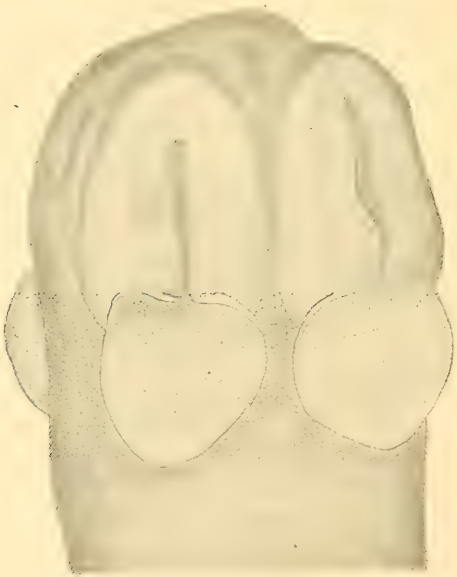


FIG. 1.—CALYPTROBOTHRIUM OCCIDENTALE. SCOLEX; SKETCH MADE FROM SPECIMEN IN GLYCERIN. ACTUAL DIAMETER OF HEAD 1.35 MM.

Neck and body crossed by minute transverse lines which make a serrate outline on the margins.

Length often as much as 250 mm., breadth 2 mm. In a mounted specimen the diameter of the head is 1.35 mm., and the breadth of the neck 1.12 mm.

Considerable variation was noted in anatomical details of the several segments which were examined, but the general plan is much like that shown in the segment sketched in fig. 2. The genital cloacæ are irregularly alternate and are on the lateral margin near the middle of the length of the segments. The cirrus lies posterior to the vagina

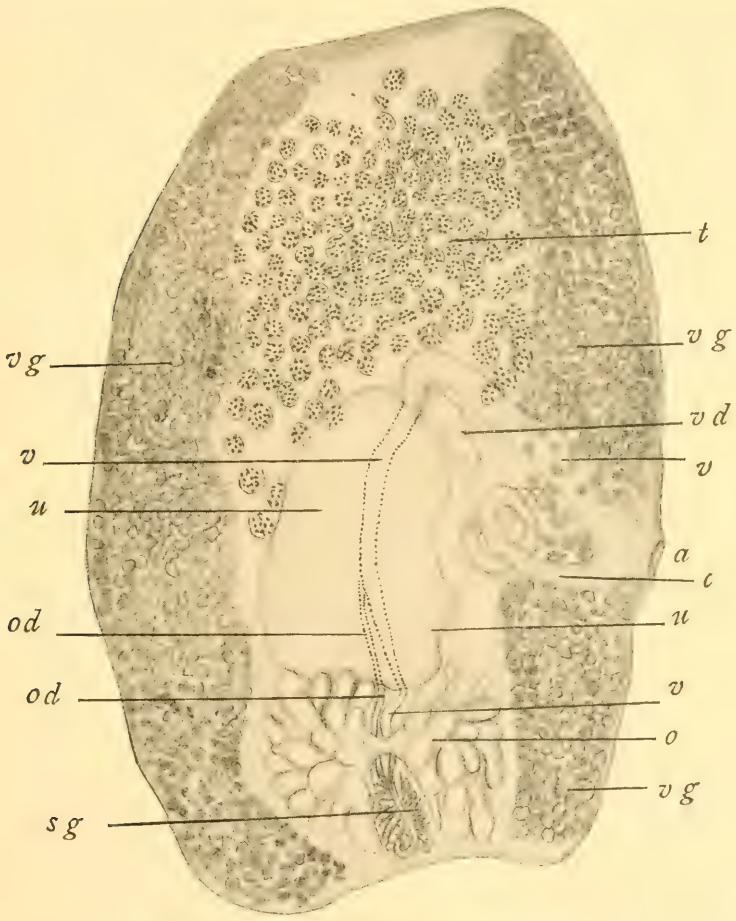


Fig. 2.—Calyptrobothrium occidentale. Free segment; sketch made from specimen, stained and mounted in balsam. Actual length 2.5 mm. *a*, genital cloaca; *c*, cirrus; *o*, ovary; *o. d.*, oviduct; *s. g.*, shell gland; *t*, testes; *u*, uterus; *v*, vagina; *v. d.*, vas deferens; *v. g.*, vitelline gland.

and is relatively long and spinose. It was not seen everted in this species, but it appears to agree closely with the same organ in *C. minus*.

The testes are globular, numerous, and lie in the anterior half of the segment along a median space equal to rather more than one-third of the breadth of the segment.

In front of the cirrus pouch, and at first parallel with it, the vagina extends anteriorly from the genital cloaca to about the median line of the segment, thence back toward the posterior end. Behind the uterus it becomes slightly convoluted, passes toward the opposite face between the two lateral ovarian masses, where it was observed in some cases to expand into a seminal receptacle. It appears to receive a short duct from the ovary—then the common duct passes to one side of the shell gland, which it enters at the posterior end. Just before entering the shell gland the common duct appears to be joined by ducts from the vitellaria. The shell gland lies between the posterior extremities of the two lateral ovarian masses.

From the anterior end of the shell gland the slender oviduct passes anteriorly, lying close beside the vagina, to open into the spacious uterus at about the middle of the length of the latter organ. The uterus lies between the anterior end of the ovary and the angle of the vagina and its breadth in the maturest segments seen was equal to nearly one-third the breadth of the segment. No ripe ova were seen in any segments which were certainly from strobiles of this species. In a few cases small spherical bodies were seen in the uterus which appeared to be unfertilized cells from the germarium. The ovary lies near the posterior end of the segment, and consists of two lateral masses on either side of the median line, each of which is made up of a number of small lobes. The vitellaria lie along the lateral margins from one end of the segment to the other. Vitelline ducts were distinguished, but their exact place of union with the duct leading from the seminal receptacle to the shell gland was not seen either in sections or in entire segments.

NOTES ON C. OCCIDENTALE MADE AT THE TIME OF COLLECTING.

August 7.—Of the 7 scoleces with strobiles the longest was 216 mm., the shortest 30 mm. Aggregate length 1,400 mm., average 200 mm. Many free segments were found, also many still attached to the strobiles which separated easily from the chain. Most of these were nearly circular in outline, with the diameter 1.5 mm.; a few were slightly longer than broad, length 2 mm., breadth 1.5 mm. These measurements were made on specimens killed in 70 per cent alcohol, in which they shrink but very little. This is in marked contrast with the behavior of the smaller form, *C. minus*, which contracts very much when placed in alcohol.

August 10.—Length of strobiles, in formalin, 100 and 140 mm.

August 12.—Several were found in one only of the two torpedoes. There were many free segments, some of which evidently belonged to *C. minus*. In my notes I record the finding of fusiform ova in some of the segments which I referred to *C. occidentale*. I have since examined a number of these segments but have failed to find ova in any segments which I could with certainty refer to this species.

An abnormal segment was found in this lot which I have made the subject of a special paper.[a]

This is a case of reduplication and reversal of parts. There are two complete sets of genital organs. The two cloacal apertures are on the same lateral margin. The ovaries are at opposite ends and the testes make a central mass common to both components. The double segment is 4 mm. in length and 2 mm. in breadth.

In this lot some of the strobiles contracted in a remarkable fashion, so as to resemble specimens of turning as seen in table legs and the like.

Fig. 3.—Calyptrobothrium minus. Scolex; sketch made from specimen mounted in balsam. Actual diameter of neck 0.22 mm.

August 18.—Material in formalin. One small specimen had contracted so as to resemble the large form. The free segments resembled *C. minus*, the scolex and fragments resembled *C. occidentale*. It was the occurrence of phenomena like these, observed in the single lot of specimens upon which the original description of the species was based, which led me to regard the two forms as varieties of the same species.

August 18.—Material in formalin. The four specimens were in poor condition; one was quite flaccid and measured 410 mm. in length.

August 19.—The single large specimen was of a faint pink color.

August 22.—Several fragments were found, but no free segments. One small specimen with thick neck, apparently a young scolex of this species.

CALYPTROBOTHRIUM MINUS, new species.

Calyptrobothrium occidentale Linton (part), Bull. U. S. Fish Comm. for 1899, pp. 298–299, pl. xli, figs. 92, 93, 96.

Head truncate, axial portion not conspicuously thickened; bothria in pairs, prominent, very flexible in life, the anterior ends with the relatively large sucker characteristic of the genus, the posterior ends slender and tapering. Neck slender, much smaller than head, with

[a] Biological Bulletin, XII, pp. 155–157, fig. 1.

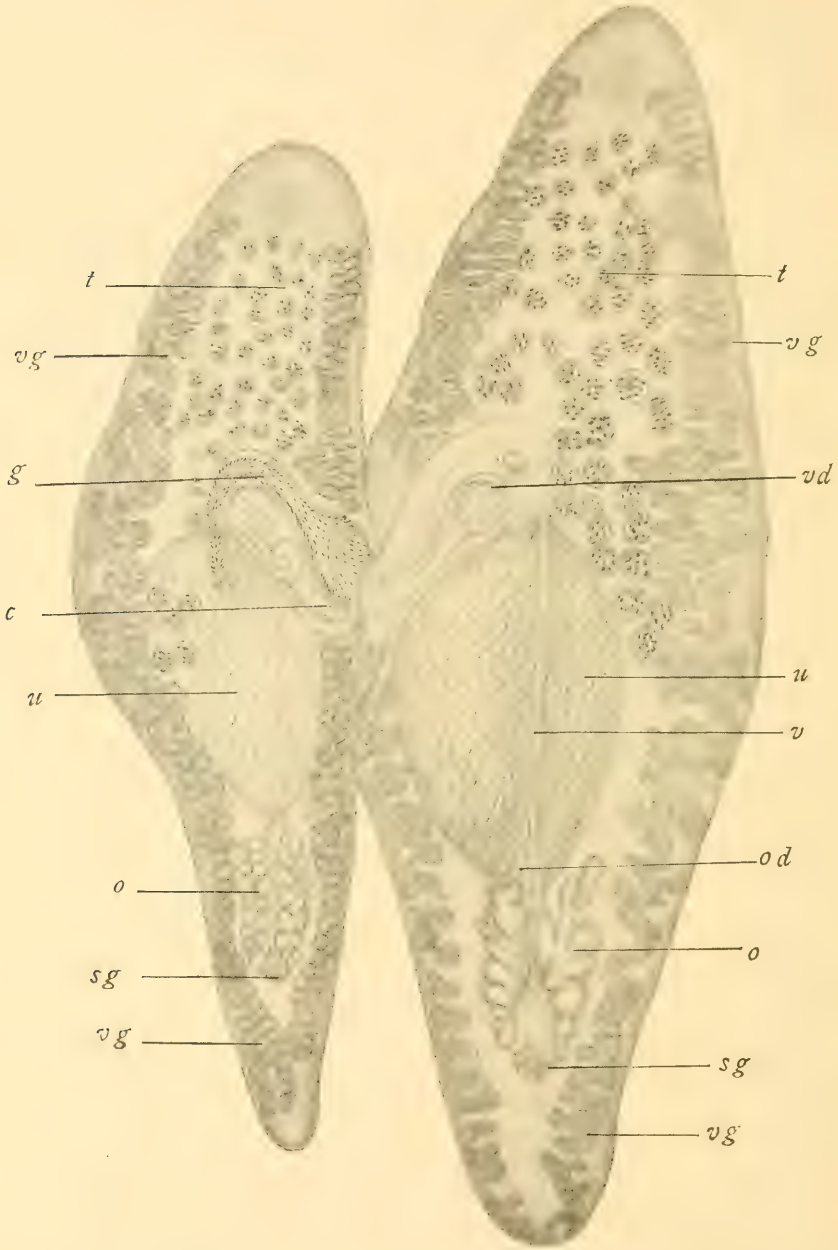


FIG. 4.—CALYPTROBOTHRIUM MINUS. FREE SEGMENTS IN COITU; SKETCHED FROM SPECIMEN STAINED AND MOUNTED IN BALSAM. ACTUAL LENGTH OF LARGER SEGMENT 4.88 MM. *c*, CIRRUS OF SMALLER SEGMENT RETRACTED; *g*, CIRRUS OF LARGER SEGMENT EVERTED AND INSERTED IN VAGINA OF SMALLER SEGMENT; *u*, UTERUS FILLED WITH FUSIFORM OVA. FOR EXPLANATION OF OTHER LETTERS SEE FIG. 2.

conspicuous serrate outlines. The segments begin remote from the head, at first much broader than long, later becoming squarish, then longer than broad, ultimately pointed at both extremities, but particu-

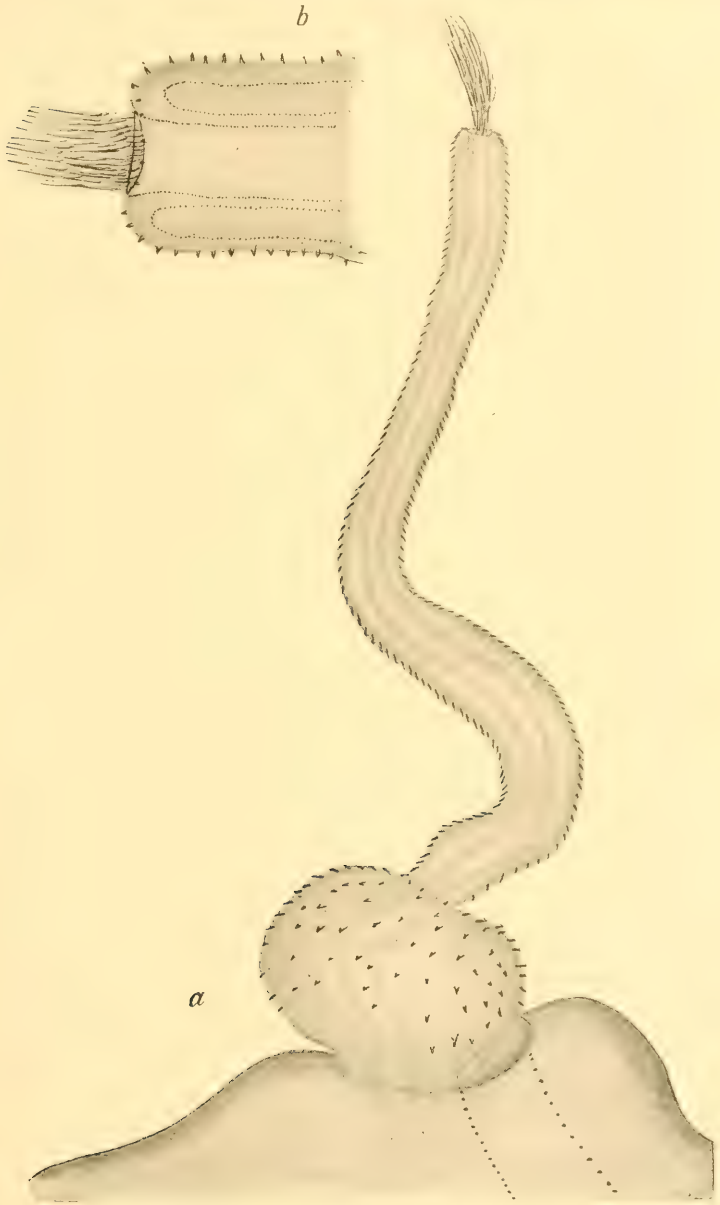


FIG. 5.—CALYPTROBOTHRIUM MINUS. *a*, CIRRUS EVERTED; *b*, DISTAL END OF SAME, MORE HIGHLY MAGNIFIED; SKETCHED FROM SPECIMEN IN SEA WATER FIXED OVER FLAME. SPERMATOZA ARE SEEN ISSUING FROM APEX. ACTUAL DIAMETER OF BASAL BULB 0.3 MM., AT DISTAL END 0.06 MM.

larly at the posterior extremity. Free, ripe segments, considerably larger, flattened, fusiform, with a mass of fusiform ova in the uterus.

The entire strobile has a tendency to become fusiform when placed in the killing fluid, in which it contracts strongly.

The general plan of the anatomy of a mature segment is like that of *C. occidentale*. The vitellaria are proportionately less voluminous and the lobes of the testes are, perhaps, relatively larger. The cirrus, which was seen everted, is provided with a basal bulb and is spinose. The shell gland is placed a little farther back in relation to the ovary than in *C. occidentale*, although this may be a character incident to the greater maturity of the segments.

Maximum length 50 mm., breadth 0.5 mm.

Diameter of head of mounted specimen 0.6 mm., of neck 0.22 mm.

NOTES ON C. MINUS, MADE AT THE TIME OF COLLECTING.

July 27.—Approximately 100 specimens were taken from a spiral valve, which had been lying for two days in 5 per cent formalin.

While collecting these specimens from a dish of sea water in which the material had been washed, a living scolex was found by Mr. Carl D. Sawyer. The specimen was, without doubt, alive, and it remained living and active for some minutes after my attention was called to it. Fig. 7 is from a sketch made of this scolex after it had come to rest. No other living specimens were found in the dish. The length of a single bothrium at rest was 0.7 mm. I can not account for the presence of this living scolex in the dish. It seems to me incredible that it came from the intestine of the torpedo, which had been in a jar of 5 per cent formalin for two days.

August 4.—Many were found in the spiral valve. The heads, as usual with this species, were, for the most part, firmly embedded in the mucous membrane of the host. Unless care is taken the heads may very easily be lost. Many mature, free segments were found in this lot, with the mass of ova showing as a dark brown spot. The mature segments evidently increase in size after separating from the strobile. The posterior segments of the strobile separate easily while they are still much smaller than the ripe segments. The posterior portion of a strobile with maturing segments is usually moniliform. The last segment is often tapering at its posterior end. There is some variation in the size of the fusiform ova; the largest were about 0.17 mm. in length and 0.017 mm. in diameter.

FIG. 6.—CALYPTROBOTHRIUM MINUS. OVA; SKETCHED FROM LIFE. ACTUAL LENGTH OF ONE 0.16 MM., DIAMETER 0.02 MM

One strobile, which measured 42 mm. in sea water shrunk to 24 mm. in 70 per cent alcohol, and another shrunk from 50 mm. to 30 mm.

August 7.—This torpedo was taken at Menemsha Bight on August 3, and kept in the aquarium until the 6th, when the spiral valve was removed and kept on ice until the 7th. The tapeworms were found to be still alive and remained moderately active for some time in sea water. Placed in 70 per cent alcohol they contracted strongly, for example, from 30 mm. to 20 mm. and from 55 mm. to 30 mm.

August 7.—No scoleces nor strobiles were obtained, but a few minute, active bodies were found in the spiral valve which looked like very small specimens of *Scolex polymorphus* until they were examined with a lens (fig. 8). Upon being magnified they were seen to be fragments of the young of this species. The anterior end for not quite half the length was armed with minute bristles; the posterior end, for a little more than half the length, with minute serrations. The length was about 0.8 mm., the breadth 0.28 mm. One was seen with the rudiments of reproductive organs.

Fig. 7.—Calyptrobothrium minus. Young scolex; sketch made from life. Actual length of bothrium 0.7 mm.

Fig. 8.—Calyptrobothrium minus. Fragment of strobile, young; sketched from life. Actual length 0.8 mm.; breadth 0.28 mm.

August 9.—Free, ripe segments were found with this lot.

August 10.—A large number of ripe segments were found in this lot.

August 12.—About 12 strobiles of this species were found in each of the two torpedoes with an enormous number of free and ripe segments. The latter were most abundant in the torpedo in which none of the larger species (*C. occidentale*) were found. The free segments are capable of making progressive movements, during which the anterior end is elongated so as to resemble the neck of certain distomes. The resemblance is heightened by the almost constant presence of a rounded knob at the anterior end. The surface of the joint is slightly roughened by very minute serrations which project posteriorly, so that the spasmodic contractions of the body, aided by a kind of flowing peristalsis, constantly propel the segment forward. I did not observe the anterior end acting as a sucker.

August 17.—About 17 strobiles of this species and two small nematodes were obtained from the torpedo which was examined on this date.

August 18.—One of the torpedoes had a few free segments which resembled this species; the other had eight strobiles, which, however, were not in good condition.

August 22.—A few of each species were found, but no free segments.

August 26.—About eight scoleces were taken from a torpedo which had been kept in the aquarium over two weeks and had died on the evening of the 25th. The worms, which were very slender, were still active. No ripe segments were found.

THE DECTICINÆ (A GROUP OF ORTHOPTERA) OF NORTH AMERICA.

By Andrew Nelson Caudell.

Custodian of Orthoptera, U. S. National Museum.

The Decticinæ are a group of locustians which are readily differentiated by their appearance from all other Orthoptera, except certain Stenopelmatinæ. The presence of wings will usually serve to distinguish them from the Stenopelmatinæ,[a] though they are generally small, especially in the female, where they are sometimes even absent. The presence of two long-winged genera breaks into the otherwise compactness of the group, making its exact definition more difficult.

The members of this group are widely distributed over the country, but are more numerous in the South and West. As a rule the species are local or very rare, but the members of two genera, *Anabrus* and *Peranabrus*, especially the former, occur in incalculable numbers, doing immense damage to cultivated crops. While most of our Decticinæ are probably primarily herbivorous, there is little doubt that many, very likely most, of them are at times carnivorous. The cannibalism of *Anabrus* and *Peranabrus* is well authenticated, and members of other genera are known to eat other insects as well as individuals of their own kind.

The life histories of the members of this interesting group are not well known. Such facts as are known regarding the habits and development of the species are given under the discussion of the various forms in this paper. Many of the species are probably nocturnal or crepuscular in habit, though certain species of some genera, *Anabrus*, *Atlanticus*, etc., are active during the day.

The natural haunts of most of the forms seem to be in grassy fields or in open woods, where they hop about in exposed positions, in striking contrast to the habits of *Ceuthophilus* and other stenopelmatid forms, which live secluded lives in caves, hollow trees, etc.

[a] *Cyphoderris* is the only winged genus of the Stenopelmatinæ found in our United States fauna, though in other regions a number of winged genera occur.

While most of the Decticinæ are winged, two genera, *Capnobotes* and *Anoplodusa*, have organs of flight sufficiently developed for flying. In most cases the wings are aborted, and the elytra, while usually larger than the wings, are useless for purposes of flight, though in the case of the males of some species they are admirably adapted to the production of sound, the tympanum being extremely well developed.

Aside from the species of *Anabrus* and *Peranabrus*, which have been variously called western cricket, mormon-cricket, coulee-cricket, etc., the members of this group have received few popular names. In a broad sense they have been called Jerusalem crickets. The name camel cricket, so far as known to the writer, is not applied to members of this group, being used only for the wingless stenopelmatid genus *Ceuthophilus*. In northern Europe certain common species of Decticinæ are known as "wart-eaters" by the peasants, who cause them to bite off warts, the belief being that warts thus injured will return no more.

In the preparation of this paper I have studied specimens of all the species. Besides the material of the U. S. National Museum I have examined that in the Scudder collection, the collections of the Academy of Natural Science of Philadelphia, of the American Museum of Natural History in New York, of the Museum of the Institute of Arts and Sciences in Brooklyn, New York, and the material in the collections of the agricultural experiment stations of Colorado and Washington. In addition to the foregoing material the private collections of Profs. Laurence Bruner, A. P. Morse, and W. S. Blatchley were examined. Probably the most valuable collection studied was that of Dr. S. H. Scudder, in Cambridge, Massachusetts. Several weeks were spent examining this famous collection, access to it and facilities for its study having been accorded me by Mr. Samuel Henshaw, curator in the Museum of Comparative Zoology. Without access to this collection a satisfactory revision of the Decticinæ would scarcely have been possible, and for the privilege of examining it I am grateful to those concerned. Especial thanks are due Professor Bruner, who, in addition to allowing me free and unrestricted access to his rich collection, presented the National Museum with many desirable specimens, some rare, others unique.

The Decticinæ, as represented in North America, are defined as follows:

Tarsi more or less depressed, the first two segments longitudinally sulcate laterally; anterior tibiæ with a slit-like foramina near the base on each side and with an apical spine on the outer side above; anterior coxæ spined. Antennæ inserted between the eyes, nearer the summit of the occiput than the upper margin of the labrum. Posterior tarsus with a free plantula at the base of the first joint. Organs of flight,

except in *Capnobotes* and *Anoplodusa*, aborted or shorter than the abdomen.

The possession of a free plantula below the base of the posterior tarsus is usually a conspicuous character (fig. 1 *p*.), but in some forms it is not so obvious, though always distinct. In many genera there is visible between the cerci of the male, below or by the side of the supraanal plate, two paired organs, usually more or less compressed. These are called supragenital-or infracercal-plates. They are generally obscure or wholly invisible, being hidden beneath the last abdominal segment, but sometimes they are more prominent than the cerci, as in *Aglaothorax* and *Neduba*.

The cerci of the male are usually of various shapes and usually furnished with teeth, furnishing good synoptic characters, but in a few genera they are simple, like those of the females. The last abdominal segment of the males is often of various shapes. As used here the last abdominal segment means the apical portion only, not the whole segment.

We have twenty genera of Decticinæ in North America. Most of the described species have been characterized by Dr. Scudder, and the genera put in tabular form by the same author.[a] His classification is based partially upon the armature of the anterior tibiæ, a character which I find most unreliable. This character is less used in the classifications of Herman[b] and Brunner.[c]

FIG. 1.—SIDE VIEW OF A FOOT SHOWING THE PLANTULA (*p*) BELOW THE FIRST TARSAL SEGMENT.

In the definition of species I find that the cerci of the male furnish valuable characters. For the differentiation of the genera I have constructed a table based on somewhat artificial characters. Many writers maintain that a table must represent the natural sequence of the subjects treated and sacrifice the question of function ability to that end. I believe, however, that the primary use of a table is to enable one to correctly place the genera or species discussed, and that the natural sequence should be otherwise indicated. The following generic key is therefore recognitional rather than natural, but I hope will serve the practical purpose intended, that of making easy the identification of the genera.

KEY TO THE GENERA OF NORTH AMERICAN DECTICINÆ.

1. Wings short, rarely longer than the pronotum and often, especially in the female, rudimentary or wanting 3
   Wings fully developed, extending far beyond the tip of the abdomen in both sexes 2
2. Prosternum armed with a pair of spines; posterior femora armed below on apical half with several distinct spines ..... *Capnobotes*, p. 310
   Prosternum unarmed; posterior femora unarmed below ..... *Anoplodusa*, p. 318

[a] Guide Orth. N. A. (1897). [b] Die Decticiden, 1874. [c] Rev. Syst. Orth., 1893.

3. Prosternum armed with a pair of spines 4
   Prosternum unarmed 12
4. Lateral carinæ of pronotum present, sharp and distinct 5
   Lateral carinæ of pronotum not indicated or very blunt and obscure 7
5. Posterior tibiæ armed below with two apical spines; ovipositor curved upward .. 6
   Posterior tibiæ armed below with four apical spines; ovipositor straight, except rarely in *A. pachymerus* ..... *Atlanticus*, p. 320
6. Lateral carinæ of the pronotum behind the point of convergence nearly straight or but little bowed outward, causing the disk of the metazone to be trapeziform, the widest part far behind the middle ..... *Neduba*, p. 295
   Lateral carinæ of the pronotum behind the point of convergence strongly bowed outward, causing the disk of the metazona to be of a more or less elongate oval form, the widest part not so far behind the middle ..... *Aglaothorax*, p. 290
7. Posterior femora long, much more than twice as long as the pronotum, extending much beyond the tip of the abdomen; pronotum without indications of lateral carinæ; ovipositor of female, where known, curved upward 8
   Posterior femora short, no more than twice as long as the pronotum, not or scarcely extending beyond the tip of the abdomen; pronotum with obscure, blunt lateral carinæ on the posterior third; ovipositor curved downward. *Apote*, p. 327
8. Pronotum posteriorly more or less elevated, saddle shaped; elytra of the male longer than the pronotum 9
   Pronotum straight above, not saddle shaped; elytra of the male less than one-half the length of the pronotum 11
9. Posterior tibiæ armed below with two apical spines; elytra of the male much swollen, apically broadly rounded ..... *Neobarrettia*, p. 302
   Posterior tibiæ armed below with four apical spines; elytra of the male but little swollen, apically narrowly rounded 10
10. Elytra of the male with the tympanum occupying more than one-half the length of the elytra beyond the pronotum; lateral lobes of the pronotum about as long as high; vertex greatly compressed ..... *Rhenia*, p. 305
    Elytra of the male with the tympanum occupying less than one-half the length of the elytra beyond the pronotum; lateral lobes of the pronotum about twice as long as high; vertex but little compressed ..... *Zacycloptera*, p. 308
11. Prosternal spines distinct; pronotum, except in *S. stevensoni*, *ateloploides*, and *bruneri*, more than 8 mm. in length ..... *Stipator*, p. 339
    Prosternal spines indistinct or wholly obsolete, rarely sharply triangular; pronotum 8½ mm. or less in length ..... *Eremopedes*, p. 330
12. Pronotum without indications of lateral carinæ on the anterior half or indicated only by color 13
    Pronotum with persistent lateral carinæ except sometimes on the anterior fourth[a] 18
13. Posterior femora, except of young specimens, less than twice as long as the pronotum 14
    Posterior femora more, usually much more, than twice as long as the pronotum 15
14. Pronotal disk smooth; anterior tibiæ armed above on both margins; cerci of the male apically furcate, the lower branch long and sharp, fig. 47 .. *Anabrus*, p. 351
    Pronotal disk rough, scabrous; anterior tibiæ armed above on the outer margin only; cerci of the male apically expanded but not furcate, the inner corner short, fig. 51 ..... *Peranabrus*, p. 362

[a] The Mexican *Idiontatus subcarinatus* has the lateral carinæ dull but distinct.

15. Lateral lobes of the pronotum not well developed (figs. 54, 56); anterior tibiæ of the female rarely with more than one dorsal spine ..... *Ateloplus*, p. 368
Lateral lobes of the pronotum well developed (fig. 60, etc.); anterior tibiæ of both sexes with more than one dorsal spine 16
16. Elytra of the female not projecting beyond the pronotum, of the male rarely projecting one-half the length of the pronotum 17
Elytra of the female projecting somewhat beyond the pronotum, of the male projecting one-half or more than one-half the length of the pronotum. *Idiostatus*, p. 373
17. Size large, pronotum 12 mm. or more in length; pronotum with distinct lateral and median carinæ on the posterior half; posterior femora less than two and one-half times as long as the pronotum; ovipositor curved lightly upward. *Anabrus*, p. 351
Size smaller, pronotum 8 mm. or less in length; pronotum without carinæ on the posterior half; posterior femora more than two and one-half times as long as the pronotum; ovipositor usually more noticeably curved upward. *Eremopedes*, p. 330
18. Posterior femora short, less than twice as long as the pronotum 19
Posterior femora long, twice or more, usually much more than twice as long as the pronotum 21
19. Pronotum posteriorly truncate, the lateral carinæ dull, straight, posteriorly somewhat divergent ..... *Peranabrus*, p. 362
Pronotum posteriorly rounded, the lateral carinæ sharp, curved outward mesially 20
20. Posterior tibiæ with two apical spines beneath; pronotum with low but persistent median carina; posterior femora much swollen basally, there more than twice as broad as apically ..... *Aglaothorax*, p. 290
Posterior tibiæ with four apical spines below; pronotum with the median carina distinct only posteriorly; posterior femora less swollen basally, there less than twice as broad as apically ..... *Plagiostira gillettei;* p. 392
21. Posterior tibiæ with two apical spines below; pronotum as in figs. 2 and 4. *Aglaothorax diabolicus*, p. 294
Posterior tibiæ with four apical spines below; pronotum not as in figs. 2 and 4 .. 22
22. Lateral lobes of the pronotum declivent, slightly so in *Steiroxys;* posterior femora three or more times as long as the pronotum, much swollen in the basal half; ovipositor curved upwards or straight 24
Lateral lobes of the prothorax perpendicular, or almost so; posterior femora little if any more than twice as long as the pronotum 23
23. Posterior femora very little swollen in the basal half; ovipositor curved downwards ..... *Plagiostira*, p. 388
Posterior femoræ conspicuously swollen in the basal half; ovipositor curved upwards ..... *Platycleis*, p. 403
24. Lateral carinæ of the pronotum bowed inward in the anterior half, posteriorly divergent, the disk of the pronotum considerably broader behind than at the middle of the anterior half (fig. 79); median carina scarcely indicated even posteriorly ..... *Idionotus*, p. 394
Lateral carinæ of the pronotum parallel, or nearly so, sometime slightly convergent in the anterior fifth (fig. 83), the disk little broader behind than elsewhere; median carina distinct and percurrent 25
25. Elytra well developed, overlapping above and projecting about one-half the length of the pronotum in both sexes 26
Elytra of the female forming slightly projecting lateral pads, widely separated above ..... *Steiroxys*, p. 404

26. Pronotal disk narrow, the lateral lobes strongly declivent; lateral carinæ distinctly convergent anteriorly (fig. 83) ..... *Clinopleura*, p. 398
Pronotal disk broad, the lateral lobes less declivent; lateral carinæ subparallel. *Platycleis*, p. 403

In the following treatment I have made little attempt at arranging the genera in a natural order, contenting myself with keeping *Neobarrettia*, *Neduba*, and *Aglaothorax* together, by reason of their group affinities, and having the genera with the prosternum unarmed following those with the prosternum armed.

AGLAOTHORAX, new genus.

Tropizaspis SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 83, 87 (part).—KIRBY, Syn. Cat. Orth., II, 1906, p. 191 (part).

Description.—Head moderate in size; eyes rounded, small, not very prominent; vertex scarcely a third as broad as the interocular space. Prosternum armed with moderately long spines, with very short spines or wholly unarmed. Pronotum nearly flat above, being but a little higher in the middle, and with low but persistent median carina; lateral carinæ scarcely indicated on the anterior fifth, from that point backwards distinct and roundly bowed outwards, making the pronotal disk broadly ovate (fig. 2), behind semicircularly rounded, the anterior margin truncate; lateral lobes well developed, nearly perpendicular, much longer than high, the posterior margin scarcely sinuate. Organs of flight aborted in the female, developed but not, or scarcely, projecting beyond the pronotum in the male. Legs short and stout, posterior femora less than twice as long as the pronotum, except in one species, and much swollen in the basal half; anterior tibiæ armed above on the outer margin with an apical spine and dorsally, opposite the end of the hearing organ, with another small spine, the latter sometimes absent; inner margin of the anterior tibiæ unarmed or with a single apical spine; posterior tibiæ with but two apical spurs beneath, the plantula moderately large and well developed. Supraanal plate concealed in both sexes, being covered by the unusually expanded and extended anal segment; subgenital plate broad, apically more narrowly rounded in the female, that of the male furnished with a pair of small apical styles, usually very inconspicuous; the male has a pair of more or less flattened organs lying between the supraanal and subgenital plates, which are termed supragenital or infracercal plates; cerci of both sexes simple, conical; ovipositor shorter than the posterior femora, curved strongly upwards.

Type.—*Tropizaspis ovata* Scudder.

This genus, known as yet only in the western part of the United States, is distinguished from *Neduba*, to which it is allied, by the broad oval thorax and the short posterior femoræ of most of the species. The general appearance of the members of the two genera are very differ-

ent and little difficulty will be found in their separation. *A. diabolica* Scudder has the long posterior femora of *Neduba*, but the form of the pronotum and the general appearance serve to locate it in this genus.

The armature of the prosternum in this genus is very variable, individuals of the same species varying from unarmed to quite noticeably spined, the spines always, however, short and blunt. Most of the specimens studied have the prosternum unarmed, very few being noticeably spined.

Three species of this genus are known. They may be separated by the following table:

KEY TO THE SPECIES OF AGLAOTHORAX.

A.—Posterior femora of female less than two times as long as the pronotum, of male little more than one and one-half times as long; ovipositor more pointed, apically armed with several, about two dozen, acute teeth. [Adult female of *A. ovatus* unknown.]

B.—Last abdominal segment of the male triangular, apically rounded; cerci scarcely longer than the basal width; infracercal plates large, together broader than the last abdominal segment, the portion beyond that segment two or more times as long as broad ..... *ovatus*, p. 291

B′.—Last abdominal segment of the male quadangular, apically truncate; cerci two or more times as long as the basal width; infracercal plates smaller, together not as broad as the last abdominal segment, the portion beyond that segment about as long as broad ..... *castaneus*, p. 293

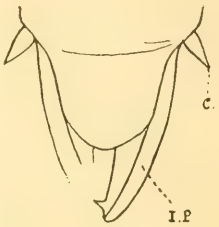
A′.—Posterior femora of female, male unknown, more than twice as long as the pronotum; ovipositor less pointed, armed at the tip with a few, about one dozen, blunt serrations ..... *diabolicus*, p. 294

AGLAOTHORAX OVATUS Scudder.

Tropizaspis ovata SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 83, 84; Cat. Orth. U. S., 1900, p. 77—WOODWORTH, Bull. No. 142, Calif. Exp. Station, 1902, p. 15.—KIRBY, Syn. Cat. Orth., II, 1906, p. 191.

Description.—Male, adult female unknown. Head of medium size, well inserted into the pronotum; vertex about one-fourth as broad as the interocular space, apically shallowly cleft; front flat, very little convex. Eyes small, round, moderately prominent, and dark brown in color. Antennæ much longer than the body, the basal segment about as broad as one of the eyes. Pronotum excessively large and posteriorly produced far over the base of the abdomen, covering the wings; lateral lobes well developed, nearly vertical, twice as long as high, the posterior border scarcely sinuate; lateral carinæ sharp, except near the anterior border, from which point they curve gradually outward, making the disk an oblong oval, semicircularly rounded behind and truncate before, the disk very gently convex with very obscure but persistent median carina. Prosternum unarmed or armed with moderately distinct spines, rarely at all sharp or conspicuous. Abdomen scarcely longer than the pronotum and much narrower, except in young

specimens, strongly compressed and carinate above; cerci of both sexes simple, conical, apically pointed, about as long as the basal width; last abdominal segment of the male apically broadly rounded; subgenital plate apically subtruncate, the styles very small and generally scarcely noticeable; infracercal plates large and long (fig. 3), extending half their length beyond the last abdominal segment, deeply and broadly sulcate on the inner side and armed at the apex on the lower margin with a short, hard, sharp tooth, rarely visible from above. Ovipositor, of a half-grown nymph, the only one seen, about two-thirds as broad as the interocular space and curved gently upward, scarcely longer than the pronotum and apically unarmed. Elytra developed as broad bulbous, strongly convex pads, not projecting beyond the pronotum, but plainly visible, forming a large tympanum. Legs short and moderately stout; anterior coxal spines sharp; fore and middle femora moderately long,



2 3

FIGS. 2–3.—AGLAOTHORAX OVATUS. 2, ADULT MALE. 3, TIP OF ABDOMEN; *c*, CERCUS; *i. p.*, INFRACERCAL PLATE.

nearly as long or somewhat longer than the greatest width of the pronotal disk, below unarmed or armed with a few minute spines; posterior femora short, less than two times as long as the pronotum and the basal half, or a little more, strongly swollen, being three or more times as broad there as the apical portion, armed on both margins below with a few small stout spines; all the femora armed above on the basal portion with a few small apically directed spines or sharp tubercles. Anterior tibiæ armed above on both sides with an apical spine, sometimes absent on the inner side, and on the dorsal surface usually with another spine as described under the genus, below armed on both margins with several spines; middle and hind tibiæ longer than their respective femora and armed above and below on both margins, the former with several on both sides and the latter with many above and a very few weak ones below, confined to the apical half.

Color brownish yellow with the borders of the pronotum and middle portions of the posterior femora above mottled with black. Antennæ with the second segment, brown, the rest fuscous, with every fifth or sixth segment light, toward the apex the light-colored ones becoming more remote from each other and more or less obscured, in some specimens the whole antenna being nearly uniformly fuscous. The anterior and intermediate femora are sometimes more or less distinctly banded on the apical half with fuscous. Some specimens are brown, but even here the black markings are easily seen.

Measurements.—Length, adult male, female in that stage unknown, pronotum, 12–13 mm.; posterior femora, 17–19; posterior tibiæ, 18–20; cerci, .75; greatest width, pronotal disk, 7–8.5; posterior femora, basal portion, 3.75–4.25; apical portion, 1.25–1.5.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

Specimens examined.—Two adult males, Los Angeles County, California, July, and one immature male, same place, June; one immature female, San Bernardino Mountains, June (Coquillett).

This species was described from a single male (fig. 2) from which the greater part of the antennæ was missing; this specimen, now in the Scudder collection in Cambridge, Massachusetts, was taken by D. A. Saunders in California, no definite locality given. I have examined the type.

The two immature specimens, male and female, in the National Museum collection are darker, especially the male, than the adults, and the pronotal disk even more rounded, the part posterior of the anterior constriction being nearly or quite as broad as long.

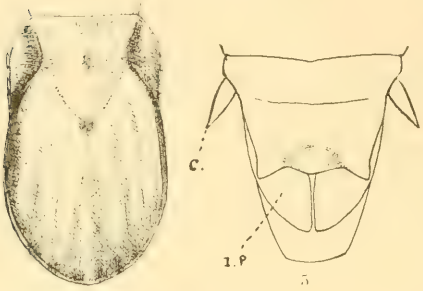
Nothing is known of the habits of this species. Mr. Coquillett thinks he took his specimens among rocks in a canyon.

AGLAOTHORAX CASTANEUS Scudder.

Tropizaspis castanea Scudder, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 83, 84; Cat. Orth. U. S., 1900, p. 77.—Woodworth, Bull. No. 142, Calif. Exp. Station, 1902, p. 15.—Kirby, Syn. Cat. Orth., II, 1906, p. 191.

Description.—In general appearance this species is very like the preceding one, being colored practically the same, some dark brown and others brownish yellow, as in *oratus*. The pronotal disk, however, has the anterior constriction slightly more remote from the anterior margin (fig. 4). The most striking difference lies in the male genitalia. Here the last abdominal segment is almost truncate, the lateral angles sharp; cerci more elongate, being at least two times as long as the basal width. Infracercal plates more depressed, together scarcely broader than the last abdominal segment and the portion beyond that segment but little longer than wide (fig. 5.) Subgenital plate nearly like that of *A. ova* the styles usually even more inconspicuous.

The fastigium of this species, as represented by a mature pair before me, is deeply sulcate, but with the sulcus anteriorly closed, forming a round pit, while in *ovatus* it is open to the end, making the vertex narrowly cleft. The prosternum is unarmed in the two specimens before me. Ovipositor of the adult quite strongly curved upward, nearly as long as the posterior femora and apically armed both above and below with about two dozen acute teeth.



4 5

FIGS. 4-5.—AGLAOTHORAX CASTANUS. 4, PRONATUM OF MALE FROM ABOVE. 5, TIP OF THE ABDOMEN FROM ABOVE; *c*, CERCUS; *i. p*, INFRACERCAL PLATE.

The measurements of an adult pair in the U. S. National Museum are as follows:

Measurements.—Length, pronotum, male, 13 mm.; female, 12.5; posterior femora, male, 19; female, 23; posterior tibia, male, 19; female, 23; cerci, male, 1; female, 1; ovipositor, 20 mm. Greatest width, pronotum, male, 8; female, 8; posterior femora, basal part, male, 4.5; females, 5; apical part, male, 1.25; female, 1.5.

Type.—In the Museum of Comparative Zoology; paratype, No. 10247, U. S. National Museum.

Specimens examined.—The U. S. National Museum contains a single pair of this species, taken by Mr. Coquillett of Los Angeles County, California, in July. The type was also examined.

AGLAOTHORAX DIABOLICUS Scudder.

Tropizaspis diabolica SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 84, 86; Cat. Orth. U. S., 1900, p. 77.—WOODWORTH, Bull. No. 142, Cal. Exp. Station, 1902, p. 15.—KIRBY, Syn. Cat. Orth., II, 1906, p. 191.

The original description of this species, of which only the female sex is known, is here quoted in full.

Head moderately large, castaneo-testaceous, the fastigium slightly broader than the basal joints of the antennæ. Pronotum with rather feebly clepsydral disk, which is considerably more than half as long again as broad, broadest but little behind the middle of the metazona, and of nearly equal breadth throughout the posterior half of the pronotum, the lateral carinæ not elevated on the prozona, on the metazona a little elevated but blunt; hind border margined, broadly rounded; median carina feeble, subequal, percurrent; the whole disk uniform castaneous, transversely pectinate, feebly rugose posteriorly, the lateral lobes fusco-fuliginous on upper half, castaneo-testaceous below. Legs luteo-testaceous, the fore and midle femora twice banded with blackish fuscous, the hind femora coarsely and a little transversely spotted above with blackish fuscous, much more than twice as long as the pronotum, the basal portion unusually stout. Abdomen dull luteo-testaceous, faintly infuscated in blotches laterally; ovipositor rather strongly curved, not narrowed in the middle

more than beyond, luteo-testaceous, a little infuscated in the apical half, nearly two-thirds as long as the hind femora, the denticulations blunt, oblique, separated by more than their own height.

Measurements.—Length of body, 25 mm.; pronotum, 10.5; breadth of same, 6; length of hind femora, 25.5; ovipositor, 16.

One female. Monte Diablo, California, August, 1872.

Type.—In the Museum of Comparative Zoology.

In length of posterior femora this species is allied to the members of the following genus, but in general appearance it is like *Aglaothorax ovatus*. Its nearest ally is probably *A. castaneus*. From that species, however, it is readily separated by the long posterior femora and the shorter and blunter ovipositor with its fewer and duller serrations. The pronotum has a distinct transverse sulcus cutting off about one-fifth of the anterior portion of the disk, not cutting the median carinæ however. The fastigium is very narrowly sulcate, being cleft as in *ovatus*. The cerci are seemingly a little more elongate than those of the female of *castaneus*.

Specimens examined.—This species is not represented in the collection of the U. S. National Museum, but I examined the type at Cambridge. The posterior femora of the type specimen measured 5.5 mm. across the basal part.

Genus NEDUBA Walker.

Neduba Walker, Cat. Derm. Salt. Brit. Mus., II, 1869, p. 250.—Kirby, Syn. Cat. Orth., II, 1906, p. 194.

Arytropteris Hermann, Verh. Zool.-Bot. Ges. Wien, XXIV, 1874, p. 204 (part).

Tropizaspis Brunner, Ann. Mus. Civ. Stor. Nat. Genova, XXXIII (2d ser., XIII), 1893, p. 187 (invalid, no species included).—Scudder, Can. Ent., XXVI, 1894, pp. 178, 180.—Woodworth, Bull. No. 142, Cal. Exp. Station, 1902, p. 14.—Kirby, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Eyes moderate, not prominent; vertex prominent, narrow, one-third or less as broad as the interocular space. Prosternum generally armed with two long sharp spines, but sometimes the spines are short and blunt and some specimens may eventually be found to have the prosternum wholly unarmed. Pronotum moderately large, dorsally very little tectiform, the median carina percurrent, more or less distinct; lateral carinæ sharp, percurrent, convergent in the anterior third or fourth. Behind the point of convergence they are nearly straight and strongly divergent, the disk posteriorly about twice as broad as anteriorly and strongly produced, the hind border semicircularly rounded, the anterior border truncate; vertical lobes well developed, narrow below, very moderately inclined, the posterior border moderately sinuate. Organs of flight aborted in the female; in the male developed, but not projecting beyond the pronotal disk. Legs long and stout; posterior femora more than twice as long as the pronotum in both sexes and strongly swollen in the basal half; anterior tibiæ

spined above on the outer margin with from one to three spines, usually two, and on the inner margin with a single apical spine; posterior tibiæ armed below with two apical spurs; plantula large and distinct, as in the preceding genus. Supraanal plate concealed beneath the last abdominal segment, which is broad in both sexes, larger in the male; subgenital plate long and broad, more narrowly rounded apically in the female; in the male furnished on each side with a short apical style; cerci of both sexes simple, conical; ovipositor noticeably shorter than the posterior femora and curved quite strongly upward.

Type.—Neduba carinata Walker.

The males of this genus, like those of the preceding one, has a pair of infracercal plates, figs. 7, 10, 11 ip. The last abdominal segment is considerably distorted in many cabinet specimens.

We have three species of this genus—the type species and two new ones herein described. These species and a varietal form of *carinata* may be separated as follows:

KEY TO THE SPECIES OF NEDUBA.

A. Last abdominal segment of the male with the outer apical corners angular; infracercal plates very broad, the portion beyond the last abdominal segment not or scarcely longer than broad and apically unarmed (figs. 7, 10).

B. Infracercal plates of the male together scarcely as broad as, or but little broader than, the last abdominal segment (fig. 7); lateral carinæ of the pronotum in the female not, or less noticeably, bowed outward behind the point of constriction (fig. 6); pronotal disk of neither sex longitudinally convex.

C. Pronotal disk unicolorous or longitudinally marked with black.

carinata, p. 296.

C′. Pronotal disk irregularly mottled with black.

carinata var. *picturata*, p. 299.

B′. Infracercal plates of the male together broader than the last abdominal segment (fig. 10); lateral carinæ of the pronotum in the female distinctly bowed outward behind the point of constriction (fig. 9); pronotal disk of both sexes, especially the female, longitudinally quite noticeably convex.

carinata var. *convexa*, p. 300.

A′. Last abdominal segment of the male with the outer apical corners rounded; infracercal plates long and slender, the portion beyond the last abdominal segment nearly three times as long as broad and armed on the inner side near the apex with a small sharp tooth (fig. 11)..... *morsei*, p. 301.

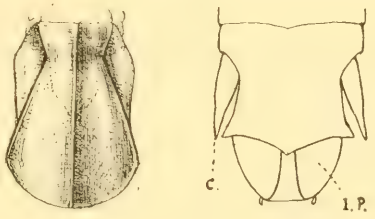
NEDUBA CARINATA Walker.

Neduba carinata Walker, Cat. Derm. Salt. Brit. Mus., II, 1869, p. 251.—Kirby, Syn. Cat. Orth., II, 1906, p. 194.

Arytropteris steindachneri Hermann, Verh. Zool.-Bot. Ges. Wien, XXIV, 1874, p. 204, pl. VI, figs. 98–102.

Tropizaspis steindachneri Scudder, Can. Ent., XXVI, 1894, pp. 180, 183; Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 84, 86; Cat. Orth. U. S., 1900, p. 77.—Woodworth, Bull. No. 142, Cal. Exp. Station, 1902, p. 15.—Kirby, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Head small, not prominent, no broader than the front of the pronotum into which it is inserted moderately deep; fastigium about one-fourth as broad as the interocular space, quite prominent, oval above, not sulcate, or very broadly and shallowy so. Eyes small, nearly round, not prominent. Antennæ long and slender, three times or more longer than the body, the basal segment large, about as broad as long and almost as large as one of the eyes. Pronotum (fig. 6) large and posteriorly much produced over the base of the abdomen, covering the wings; lateral lobes shallow, rarely half as deep as long, posteriorly distinctly sinuate; lateral carinæ sharp and distinct, converging in the anterior fifth and then diverging posteriorly, usually straight behind the point of convergence but sometimes a little, or rarely considerably, bowed outwards; median carina distinct and persistent but very slightly elevated; pronotal disk inconspicuously ruggose, more distinctly so in the male, transversely a little concave or, more usually, flat and slightly tectiform, marked at the narrowest point with a faint transverse sulcus, not however severing the median carina; posterior margin broadly rounded; front margin truncate. Prosternum armed with two spines, usually long and distinct but sometimes short and blunt. Wings aborted in the female, in the male the elytra form well developed, strongly convex tympani, easily seen but not projecting beyond the pronotal disk. Legs long and slender, the posterior femora more than two times as long as the pronotum; all the femora unarmed below but above there are a number of sharp, backwardly directed spines, more numerous on the posterior femora; anterior tibiæ armed above on the outer carina with two spines, one basal and one terminal, probably sometimes with a median spine also; on the inner margin the anterior tibiæ generally bears a single apical spine and armed below on both sides with seven or eight spines; intermediate tibiæ armed on both margins above and below; posterior tibiæ also armed on both margins above and below, above with about a dozen stout ones on each margin and below with a few weak slender ones. Abdomen usually somewhat compressed, normally about as wide as the pronotum, distinctly but slightly carinate above. Cerci of both sexes simple, round and tapering to a sharp tip, about four times as long as the basal breadth, often, at least in the female, five times as long; subgenital plate apically narrowly rounded and unarmed in the female, in the male apically truncate and armed with a pair of distinct but short apical styles, the styles usually about two times as long as broad; last



6 7

FIGS. 6–7.—NEDUBA CARINATA. 6, PRONOTUM OF MALE FROM ABOVE. 7, TIP OF ABDOMEN OF THE MALE FROM ABOVE; *c*, CERCUS. *i. p*, INFRACERCAL PLATE.

abdominal segment and infracercal plate of male shaped as shown in fig. 7, the projecting portion of the latter scarcely longer than broad and their combined width scarcely as great as that of the former. Ovipositor short, rarely more than two-thirds as long as the posterior femora, about as broad or considerably broader than the fastigium and gently curved upward, the tip armed with a dozen or more sharp elongate teeth on the upper margin and a lesser number below.

General color, light brownish, with darker mottlings, sometimes uniformly yellowish; lateral lobes of the pronotum usually infuscated, the disk unicolorous or marked with longitudinal dusky stripes; anterior and intermediate tibiæ and femora usually with one or two more or less conspicuous broad black bands, besides other smaller mottlings; posterior femora longitudinally infuscated on the outer face, sometimes with the color broken by three or four light spots; abdomen almost always with a pair of broad dark-colored subdorsal stripes extending from the pronotum back across the basal half of the abdomen and then deflexing toward the sides, where they meet an indefinite area of infuscation that envelopes the sides of the apical portion of the abdomen. Ovipositor brownish, usually about the same shade as the ground color of the body.

Measurements.—Length, pronotum, male, 9 mm.; female, 8.5–9.5; posterior femora, male, 19, female, 20–22; ovipositor, 13–17; width at widest point, pronotum, male, 6.5, female, 6.5; posterior femora, basal part, male, 3.5, female, 4–4.25; apical part, male, 1, female, 1.12; ovipositor, at middle point, 1.5–1.75 mm.

Type.—In the British museum in London.

Specimens examined.—The National Museum contains three adult males, four females, and several nymphs. These are from Seattle, Washington, Palo Alto, California, and Humboldt and Siskiyou counties, California. Also four females from Wellington, British Columbia (Toylore). The Palo Alto specimen, one male, was taken in November; an adult from Seattle was taken in August. The nymphs were taken in March at Seattle and in June in Humboldt county, California. I have also specimens taken at Eureka, California, and nymphs taken at Sierra Madre, California, on May 30, 1906.

I am indebted to Messrs. Kirby and Waterhouse for notes on and drawings of the type of *carinata*. From a rough sketch sent the pronotum is seen to be more bowed out posteriorly than usual, something as in *N. morsei*.

This Pacific coast species is said to extend east to Texas. Scudder mentions a specimen labeled as having been taken in Nebraska by Suckley, but he thinks it wrongly labeled, as it is not elsewhere recorded from that region, and Suckley also collected in the Northwest.

Carinata is the commonest species of the genus. The Scudder col-

lection contains nine males and seven females, some marked types, but erroneously so.

Prof. A. P. Morse, who has taken this species in the west, says it is found in deciduous woodlands and shrubbery, hopping about on the carpet of fallen leaves, with which its coloration agrees. This is probably true of the other members of the genus. Some nymphs referred with doubt to this species have the lateral carinæ of the pronotum nearly parallel.

At Eureka, California, July 5, 1906, I took three adult males and one female nymph. They were in just such a locality as described by Morse. The males were stridulating and were quite numerous, being heard in the grass along the road in open ground well removed from woodland, even in the edge of town. The male commences to stridulate about dusk, or a little before, and the sound is similar to that made by a person gritting the teeth together, but in a higher key. The chirp is repeated from a few, three or more, to as many as about thirty times, the largest number noted by me being twenty-nine, while the fewest, when the insect was seemingly undisturbed, was three. The rapidity of the beats was at the rate of about one hundred a minute. The singer was usually found among dead leaves beneath briars or shrubs. They do not leap readily, seeming to depend for protection on their surroundings rather than by their activity. So well do they harmonize with their surroundings that it is almost impossible to discover them as long as they remain quiet. When their retreat is beneath a bunch of briars, as is often the case, they are practically safe from capture. I took the typical form and the var. *picturata* singing within a few yards of each other.

NEDUBA CARINATA var. PICTURATA Scudder.

Tropizaspis picturata SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 83, 85; Cat. Orth. U. S., 1900, p. 77.—KIRBY, Syn. Cat. Orth., II, 1906, p. 191.

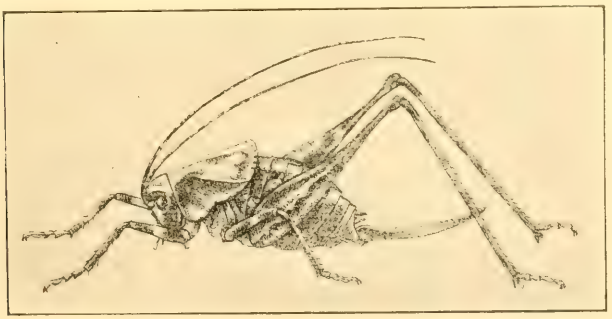


FIG. 8.—NEDUBA CARINATA VAR. PICTURATA. ADULT FEMALE.

Description.—This is a mere color variety of *carinata*, differing from the typical species only by having the pronotum irregularly mottled above instead of unicolorous or longitudinally striped. Scudder

characterized it as having the ovipositor narrowed mesially and narrower than the fastigium. The types were examined and the characters are, in my opinion, not specific. The thoracic mottling and the slight mesial narrowing of the ovipositor are not correlated, and the male genitalia, while somewhat shrunken, seem to be just as in typical *carinata*.

Type.—In the Museum of Comparative Zoology.

Specimens examined.—The National Museum contains two adult males, one female (fig. 8) and a nymph from Seattle, Washington; one adult on September 20, the others without dates, and one female, nymph from Humboldt County, California, June 9; also a male from Eureka, California, July 5, 1906.

NEDUBA CARINATA var. CONVEXA, new variety.

Description.—Differing from typical *carinata* in several particulars. The size is somewhat greater as represented by the three specimens before me and the color seems lighter. The pronotum of the only female seen (fig. 9) is more convex on the disk and is longitudinally

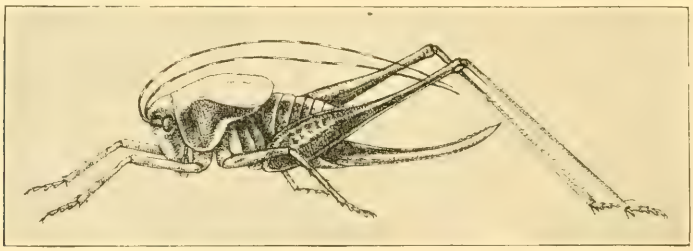


FIG. 9.—NEDUBA CARINATA VAR. CONVEXA. ADULT FEMALE.

more convex than in any other specimens seen, that of the male seemingly more distinctly rugose than common in *carinata*. The lateral carinæ of the pronotum of the female are more bowed outward than in allied species, giving it a slight superficial resemblance to members of the preceding genus. The median carina is about the same as in *carinata*. Prosternum armed with moderately long spines, rather short in the male specimens. The ovipositor is longer than usual in allied forms, but when a number of specimens are examined it will probably be found to vary as it does in typical *carinata*. The infracercal plates of the male, while shaped essentially as those of the typical form, are apparently broader, their combined width being generally greater than that of the last abdominal segment, probably due, however, to the greater relaxation of the genital organs of the specimens examined rather than to the actual width. Last abdominal segment of the male with the posteriolateral corners more produced than in typical *carinata* and the apical styles of the subgenital plate

of the male are usually shorter, being no longer than broad (fig. 10). The anterior tibiæ are armed above on the outer margin with two spines and on the inner margin with one apical spine. The color of the male is a light yellowish brown, the sides of the pronotum and portions of the posterior femora more or less infuscated and all the legs rather obscurely banded as in the typical form. The female has the disk of the pronotum a uniformly yellowish brown, the lateral lobes black with the lower and hinder margins narrowly emarginate with yellowish brown. The abdomen is colored as in typical *carinata* and the antennæ of both sexes are banded as describe dunder that form.

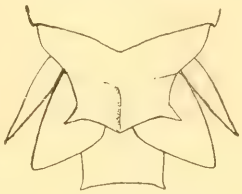


FIG. 10.—NEDUBA CABINATA VAR. CONVEXA. TIP OF ABDOMEN OF ADULT MALE FROM ABOVE.

Measurements.—Length, pronotum, male 9.5 mm., female 10.5; posterior femora, male 20, female 23; ovipositor, 20; width pronotum at widest point, male 7–7.5, female 7; posterior femora, basal part, male 3.75, female 5; apical part, male 1, female 1.5; ovipositor at middle, 1.5.

Types.—Cat. No. 10160 (male) U. S. National Museum and (female) American Museum of Natural History, New York.

Specimens examined. One male, Mount Shasta, California (Behrens, collector), and one male, one female, Napa County, California (Edwards, collector).

This variety, of which the pair from Napa County, California, were loaned me for study by William Beutenmüller, of the American Museum of Natural History, of New York, is quite distinctive in general appearance. I have hesitated to call it a distinct species, though it may eventually prove to be such.

NEDUBA MORSEI, new species.

Description.—In general appearance, both as to form and color, this species is very similar to *carinata*. The pronotum is somewhat mottled, as in *carinata picturata*, and the lateral carinæ are slightly bowed outward behind the point of greatest constriction. The most important characters, however, that serve to separate it from its ally, *carinata*, lie in the male abdominal characters. Here the last abdominal segment is apically rounded, instead of truncately sinuate as in *carinata*, and the infracercal plates are long, slender, and internally armed near the tip with a short spine or tooth; that part of the infracercal plate projecting beyond the last abdominal segment is three times as long as broad, instead of scarcely longer, as in the other forms (fig. 11). The cerci are about two times as long as the basal width, instead of three or four times as long. The anterior tibiæ are armed above on the outer margin with three spines.

Measurements.—Length, pronotum, 9 mm.; posterior femora, 16; width of pronotum at widest point, 6.5; posterior femora on basal half, 3.5.

Type.—Collection of A. P. Morse, Wellesley, Massachusetts.

Specimens examined.—One male, the type, Mount Wilson, Altadena, California, July 27, A. P. Morse.

I take pleasure in naming this structurally distinct species in honor of the collector, Prof. A. P. Morse, of Wellesley, Massachusetts.

FIG. 11.—NEDUBA MORSEI. TIP OF ABDOMEN OF ADULT MALE FROM ABOVE.

This is the specimen mentioned by Doctor Scudder.[a] While museum pests have done much damage to the specimen, the most important characters are fortunately intact or not materially injured.

The three following genera are based on the male sex only, the females of none of the species being known.

NEOBARRETTIA Rehn.

Neobarrettia REHN, Ent. News, XII (1901), p. 16.—KIRBY, Syn. Cat. Orth., II, 1906, p. 182.

Description.—Head medium; eyes small. Thorax saddle-shaped, posteriorly abruptly elevated, much more so than anteriorly, subtruncate both before and behind and scarcely produced posteriorly. Lateral lobes of the pronotum vertical, posterior border scarcely sinuate; lateral and median carinæ not indicated except on the elevated posterior portion where they are present but very rounded. Prosternum armed with a pair of long, sharp spines. Mesosternum also armed with a stouter pair of spines. Wings apparently aborted, or scarcely developed, the elytra almost twice as longs as the pronotum, very broad and somewhat swollen, apically rounded, the transverse vein of the tympanum very stout. Posterior femora more than three times as long as the pronotum and much swollen on the basal half; anterior tibiæ armed above on the outer side only with three spines; posterior tibiæ armed below with but two spurs. Plantula very short, not prominent. Supraanal plate scarcely visible beneath the last abdominal segment, which is short and broad, mesially emarginate; cerci broad and stout, about twice as broad as the basal width and apically abruptly bent inwards, the tips forming a blunt, back tooth; subgenital plate short and broad, with two triangular, pointed apical styles.

Type.—*Capnobotes imperfecta* Rehn.

This genus, like the two preceding ones, is a member of Brunner's division Rhacoclees, distinguished by having but two apical spurs below on the posterior tibiæ. Unlike *Aglaothorax* and *Neduba* how-

[a] Proc. Amer. Acad. Arts Sci., XXXV, 1899, p. 87.

ever, the males are not furnished with conspicuous infra-cercal plates. The elongate and somewhat swollen elytra and saddle-shaped thorax easily distinguish this Mexican genus from its allies. There is but one species, as follows:

NEOBARRETTIA IMPERFECTA (Rehn).

Capnobotes imperfectus REHN, Trans. Amer. Ent. Soc., XXVII, 1900, p. 89.—KIRBY, Syn. Cat. Orth., II, 1906, p. 182.
Neobarrettia imperfectus REHN, Ent. News, XII, 1901, p. 16.

Description.—Head scarcely broader than the anterior part of the pronotum, into which it is quite deeply inserted; fastigium extremely narrow, scarcely a fourth as broad as one of the eyes, no more than a tenth as broad as the interocular space, above narrowly sulcate; occiput smooth and roundly tumid, not elevated above the anterior edge of the pronotum. Eyes small, nearly round, quite prominent. Antennæ long and slender, the basal segments very large and broad,

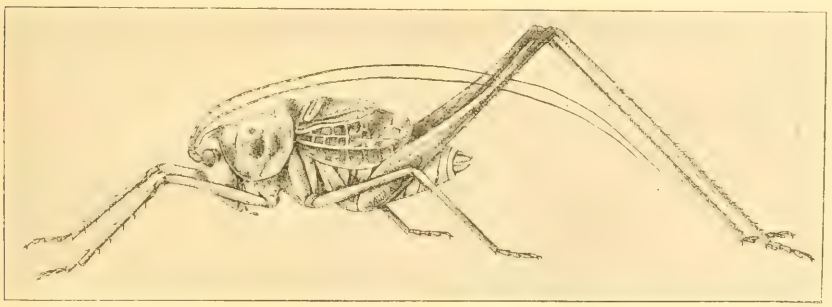


FIG. 12.—NEOBARRETTIA IMPERFECTA. ADULT MALE.

irregular in shape, the fastigium crowded between them. Pronotum saddle-shaped but not constricted at any point, scarcely noticeably broadened behind; pronotal disk crossed at the middle of the anterior and posterior halves by transverse sulci, the anterior one slight and meeting the edge of the pronotum halfway down the lateral lobe and the posterior one very broad and meeting the posterior margin of the lateral lobes just before the humeral angle, which is broadly rounded. The pronotum behind this posterior sulcus is abruptly and conspicuously elevated and here furnished with rounded lateral and median carinæ which are not present on the anterior part of the pronotum; lateral lobes well developed, less than twice as long as deep and scarcely sinuous behind; pronotal disk slightly emarginate both before and behind. Prosternal spines long and sharp, mesosternal spines thicker. Anterior coxal spines somewhat recurved, sharp and strongly compressed basally; posterior femora long and slender, strongly swollen on the basal half, armed on both margins, beneath with short spines; anterior and intermediate femora long, considerably longer than the

pronotum, armed as the posterior femora; anterior tibia armed on the outer margin above with three spines, unarmed on the inner margin; all the tibiæ armed below on both margins with long spines, the middle ones armed above with three or four spines on each margin and the posterior ones armed above on the apical two-thirds with several spines on each margin. Wings not visible beneath the elytra, which are very broad, nearly twice as long as the thorax and considerably swollen in the middle, the lateral fields nearly vertical, the main oblique vein of the tympanum very large and stout, the whole transparent and reticulated with very stout veins. Abdomen plump, cylindrical, not carinate above, extending well beyond the tips of the elytra except in dried specimens where it is much contracted. Cerci (fig. 13) about two times as long as the basal breadth, tapering to the apex, which is abruptly curved inwards, forming a slightly recurved smooth, hard, black tooth; subgenital plate short and broad, mesially notched and with a distinct median carina below; apical styles distinct in the specimens examined, but are said to be sometimes absent. The color is described by Rehn as follows:

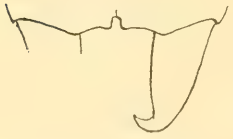


FIG. 13.—NEOBARRETTIA IMPERFECTA. TIP OF ABDOMEN OF MALE FROM ABOVE.

Head and pronotum dull lemon-yellow, washed above with wood-brown (faintly in one individual), lightest below. Antennæ wood-brown. A dull, dark brownish line is continued back of the eye on the superior portion of the lateral lobes of the pronotum. Central portion of the pronotum marked with four rather regular blotches of blackish; the sloping lateral margin with a broad band of white. Elytra green, external border lightest, darkest centrally. Abdomen rich wood-brown, scrumbled with dull ochre, beneath pale yellowish. Femora pale yellowish green, the posterior part infuscated in several specimens; extremities black in the posterior pair. Tibiæ the same, washed above with a dull purplish brown. Tarsi blackish.

Measurements.—Length, pronotum, 5 mm.; elytra, 8.5; posterior femora, 19; posterior tibia, 20; width, pronotum, in front, 4.5, behind, 5; posterior femora, basally, 3; apically, 1.

Type.—In the Academy of Natural Sciences, Philadelphia; paratype, No. 10161, U. S. National Museum.

Specimens examined.—The type, shown in fig. 12, a single male taken by O. W. Barrett at Rio Cocula, Guerrero, Mexico, in December, 1898, was loaned to me for study by Rehn. Bruner has three males, also taken by Barrett in Mexico, at Cocula and Igula in Guerrero. One of these specimens, a paratype, has been presented to the National Museum by Bruner.

The following facts relative to the life and habits of this interesting insect are quoted from notes by the collector.[a]

[a] Trans. Amer. Ent. Soc., XXVII, 1901, p. 229.

The locality where the specimens were taken is the least known corner of Mexico—hilly, with dried up vegetation during about one-half of the year. The species seems to be cupuscular in habits. It was almost impossible to find a specimen during the daytime, and I do not believe the males stridulate long after dark, for I slept several nights in a tent in the "Chaparral" among them, and do not remember hearing them after dark. The shrubs which they inhabit are a compact growing species, affording a place of concealment by day, while their thick tops offer unusual advantages for the roof-garden concerts of the stridulators at twilight. The stridulation is feeble and not continued beyond a few seconds with a period of rest. When captured they offer little or no defense, and their saltatory powers are small and not willingly used.

REHNIA, new genus.

Description.—Male, female unknown. Head medium, slightly broader than the anterior portion of the pronotum; eyes large and prominent; vertex extending between the basal segments of the antennæ as a much compressed projection, distinctly separated from the face. Pronotum of medium size, moderately produced posteriorly and the disk abruptly elevated behind as in the preceding genus; the anterior and posterior margins of the pronotum are truncate or broadly rounded; lateral lobes deep, nearly vertical, margins nearly straight, humeral angle scarcely indicated; lateral carinæ not indicated except very slightly so on the posterior margin; median carina not indicated. Prosternum armed with a pair of long sharp spines. Organs of flight fairly well developed, nearly or quite two times as long as the pronotum, the elytra apically narrowly rounded, tympanum well developed, occupying one-half the length of the elytra. Legs long and stout, the posterior femora about three and one-half times as long as the pronotum and considerably but gradually swollen on the basal half, the genicular spines sharp and prominent; posterior tibiæ a little longer than the corresponding femora and armed below with four terminal spurs; plantula short; anterior tibiæ armed above on the outer carina only with five spines. Subgenital plate moderately broad and long, apically triangularly incised and with a pair of short stout apical styles; supraanal plate triangular, nearly hidden; last abdominal segment broad and short, roundly incised mesially; cerci basally flattened, inwardly concave, the apex slender and incurved, the upper portion of the flattened base slightly produced in the form of an inner tooth.

Type.—*Rehnia victoriæ*, new species.

Superficially this genus bears some resemblance to *Neobarrettia* Rehn, but structurally it is very different, in a natural classification falling into a different section, the former genus belonging to the section Rhacoclees and *Rehnia* to the section Gampsoclees.

There are two species of this genus before me, the type from Mexico and a second very distinct species supposedly from the United States. These two species may be separated as follows:

KEY TO THE SPECIES OF REHNIA.

A. Spines of the legs inconspicuous, those of the posterior femora colored similarly to the femora themselves; size smaller ..... *victoriæ*, p. 306

A'. Spines of the legs large and conspicuous, those of the posterior femora piceous, strongly contrasted with the color of the femora themselves; size large ..... *spinosa*, p. 307

REHNIA VICTORIÆ, new species.

Description.—Male, female unknown.—Head deeply inserted into the pronotum which is slightly flared anteriorly to receive it; interocular space three times as broad as one of the eyes; face broad and flat, not strongly convex; eyes round and very prominent; antennæ long and slender, the basal two segments much enlarged. Pronotum smooth and dorsally evenly rounded, the posterior margin very slightly but abruptly elevated, where the lateral carinæ are very obscurely indicated; anterior and posterior margins of the pronotal

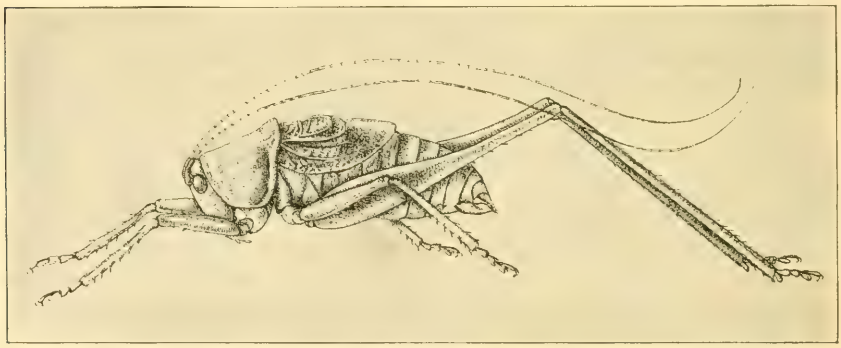


FIG. 11.—REHNIA VICTORIÆ. ADULT MALE.

disk subtruncate or very gently rounded; prosternal spines moderately long, slender, and very sharp. Elytra a little longer than the wings, not quite two times as long as the pronotum. Legs long and quite stout, all the femora armed below on both margins for nearly the entire length with stout triangular spines; posterior and intermediate tibiæ spined above and below on both margins, those of the former shorter than the tibial depth those of the latter equal to or greater than the tibial depth; anterior tibiæ armed below on both margins with spines longer than the tibial depth, above on the outer margin only with five spines about as long as the tibial depth. Abdomen plump, rounded, without dorsal carina; cerci but little longer than the last abdominal segment (fig. 15), the slender apical portion produced as a long incurved tooth; terminal styles of the subgenital plate about three times as long as the basal breadth.

General color green; head paler on the face, the two first segments of the antennæ pale green, the rest reddish brown; eyes reddish brown;

pronotum tinged with reddish brown dorsally and the posterior border of the lateral lobes quite conspicuously margined with creamy white; elytra tinged above, especially along the lateral margins of the tympanum, with brown; abdomen shaded with light brown; spines of the legs tipped with black.

FIG. 15.—REHNIA VICTORIÆ. TIP OF ABDOMEN OF MALE FROM ABOVE.

Measurements.—Length, pronotum, 7.25 mm.; elytra, 12.5; posterior femora, 26; width, pronotum on the hinder portion of the disk, 4; posterior femora at broadest point, 3.5.

Type.—Cat. No. 10162 U. S. National Museum.

Specimens examined.—One male, the type (fig. 14), Victoria, Guerrero, Mexico. O. W. Barrett, collector.

This interesting insect bears quite an obvious resemblance to the *Neobarrettia imperfecta* of Rehn, but the larger and more pointed elytra and larger size will readily serve to distinguish it from that species.

REHNIA SPINOSA, new species.

Description.—Male, female unknown. Structurally very closely allied to *victoriæ*, but bears scarcely any resemblance to that species.

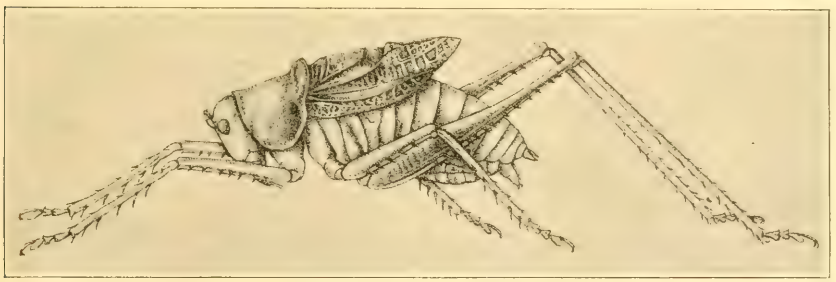


FIG. 16.—REHNIA SPINOSA. ADULT MALE.

The eyes are even more prominent than in *victoriæ* and the head is proportionately broader, being broader than the anteriorly flared pronotum, which is shaped as described under the preceding species, but considerably more elevated posteriorly and anteriorly. Prosternal spines slightly longer than in *victoriæ*, but the armature of the legs and the formation of the wings and abdomen are as described under that species. The cerci are, however, longer and less incurved apically (fig. 17).

General color uniformly yellow; eyes brownish yellow; tympanum of the elytra dark brown, and the spines of all the femora are wholly black, and those of the tibiæ are black at the base and apex, the middle part yellowish; pronotum margined anteriorly with a fine line of black and on the anterior border and along the posterior margin of

the lateral lobes with creamy white; meso-and metapleura each with an elongate white spot.

Measurements.—Length, pronotum, 10 mm.; elytra, 21; posterior femora, 36; width, pronotum at the hinder part of the disk, 6.5; posterior femora at widest point, 5.

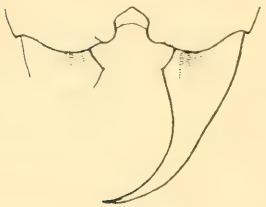


FIG. 17.—REHNIA SPINOSA. TIP OF ABDOMEN OF THE MALE FROM ABOVE.

Type.—Cat. No. 10163, U. S. National Museum.

Specimens examined.—One male, the type (fig. 16), Texas.

This large yellow species with the conspicuous black spines is a very noticeable insect. The piceous spines on the yellow femora serve to impart to it a very spinose appearance, quite different from any other of our native forms. Bruner, who kindly presented this curious creature to the National Museum, is authority for the above habitat, the specimen itself being without label of any sort. But he expresses himself as being very positive of the locality. It is very surely an introduced species, probably coming from Mexico or Central America.

ZACYCLOPTERA, new genus.

Description.—Male, female unknown. Head moderate; eyes medium in size, prominent; vertex not prominent, narrow, scarcely as broad as the basal segment of the antennæ, about one-fifth as broad as the interocular space. Pronotum large, produced posteriorly over the base of the abdomen; lateral lobes considerably inclined, about twice as long as high, rounded below, posteriorly broadly sinuate; disk rounded, slightly elevated on the posterior fourth, anteriorly truncate, posteriorly broadly rounded; lateral carinæ indicated on the posterior fourth by rounded shoulders, anteriorly represented only by a light-colored stripe; median carina not indicated. Prosternum armed with a pair of short spines. Wings and elytra of equal length, projecting beyond the pronotum a little more than the pronotal length; wings exceedingly broad, decidedly broader than long and uniformly piceous; elytra apically narrowly rounded, the tympanum occupying about one-third the length of the elytra beyond the pronotum. Legs long and slender; posterior femora more than twice as long as the pronotum and very little swollen on the basal half, armed below on both margins with a few very small sharp spines; posterior tibiæ armed below with four apical spurs; anterior tibiæ armed above on the outer carina only with three spines. Tip of the abdomen much shrivelled in the only specimen seen, but the supraanal plate seems obscure and the last abdominal segment is long and deeply and narrowly cleft; cerci short, about twice as long as the basal width and apically depressed and formed into two teeth, directed inward and a little downward.

Type.—Zacycloptera atripennis, new species.

This is a very distinct genus. It is apparently the most nearly related to the preceding one, but does not resemble that genus in any way. The legs are longer and more slender than common in this group.

But one species is known, the type from Nevada. It is described as follows:

ZACYCLOPTERA ATRIPENNIS, new species.

Description.—Male, female unknown. Head slightly broader than the anterior portion of the pronotum, into which it is moderately well inserted; vertex very short and narrow, but not compressed, scarcely

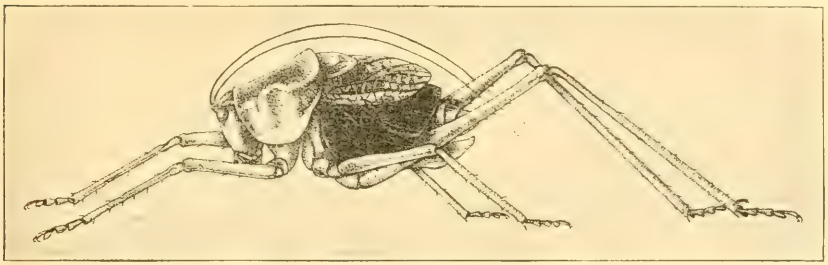


FIG. 18.—ZACYCLOPTERA ATRIPENNIS. ADULT MALE.

half as broad as one of the eyes; eyes rounded, moderate in size, and very prominent, being semiglobular. Antennæ slender, the basal segment about half as broad as one of the eyes, being a little broader than the vertex as viewed from in front. Pronotum and wings as described under the genus. Legs long, the posterior femora but little swollen basally, shaped as in the genus *Plagiostira*. All the femora are sparsely spinose below on both margins, the spines usually little more than acute tubercles. Abdomen mostly, at least in dried specimens; nearly concealed beneath the ample wings; cerci short and broad, the depressed tip formed into two acute inwardly directed teeth, the tips slightly decurved (fig. 19).

FIG. 19.—ZACYCLOPTERA ATRIPENNIS. TIP OF ABDOMEN OF MALE FROM ABOVE.

General color a very light brown, nearly white, except the elytra and top of the pronotum, which are brown, and the wings, which are uniformly piceous. The upper portion of the lateral lobes of the pronotum is brown, and separated from the brownish disk by a moderately broad pallid streak, less distinct posteriorly. These pallid streaks approach slightly in the middle, giving the pronotum somewhat the appearance of possessing lateral carinæ. The eyes are brown and the top of the head and the tibiæ are slightly embrowned, the tarsi and abdomen more so.

Measurements.—Length, pronotum, 9 mm.; elytra, 11; posterior femora, 21; width, pronotum, across metazone, 6; posterior femora, at widest point, 3; at narrowest point, 1.5.

Type.—Cat. No. 10164, U. S. National Museum.

Specimens examined—One male, the type (fig. 18), Hawthorne, Nevada, June (Wickham).

This interesting insect, donated to the National Museum by Professor Bruner, is very peculiar in the posterior femora being but comparatively little swollen basally and by the round, coal-black wings. In both these respects it is allied to the members of the genus *Plagiostira*, but the armed prosternum and non-carinate pronotum prove it to be not at all allied to that genus.

CAPNOBOTES Scudder.

Capnobotes Scudder, Can. Ent., XXIX, 1897, pp. 73, 74; Guide N. A. Orth., 1897, p. 55; Cat. Orth, U. S., 1900, p. 76.—Cockerell, The Ent., XXXVII, 1904, pp. 178–181.—Kirby, Syn. Cat. Orth., II, 1906, p. 181.

Description.—Head moderately large, eyes of medium size, hemispherical; vertex prominent, narrow, about one-half as broad as one eye. Prosternum armed with a pair of sharp spines; mesosternum and metasternum with the angles spinelike, those of the mesosternum especially often forming well-developed spines, though blunter than those of the prosternum. Pronotum of moderate size, considerably produced backward over the base of the wings; disk flat behind, in front convex, posterior margin rounded, anterior margin truncate; lateral carinæ subparallel, distinct only on the hinder portion; median carina absent; lateral lobes well developed, nearly as deep as long, almost vertical, the posterior margin sinuate, the humeral angle distinct; lower border straight, slightly oblique. Wings and elytra both present and well developed, longer than the body in both sexes; elytra long and slender, those of the male furnished with an oval transparent spot on the right tympanum, the corresponding spot of the left tympanum opaque; wings long and broad, rapidly tapering apically. Legs moderately slender; posterior femora about four times as long as the pronotum, considerably swollen on the basal half and armed below with a number of small spines; tibiæ of approximately the same length as the corresponding femora, the anterior ones armed above on both margins or only on the outer, the number of spines variable, below armed on both margins, sometimes scarcely so on the outer margin. Subgenital plate apically triangularly forked, the branches carinate below and terminating in the male with a pair of cylindrical styles; supraanal plate concealed beneath the last abdominal segment, which projects backward as two long processes, being furcate nearly to the base; cerci long, subcylindrical, simple in the female, in the male toothed on the inner

side near the tip; ovipositor somewhat shorter than, or about as long as, the posterior femora, curved slightly downward.

Type.—*Locusta fuliginosa* Thomas.

This genus is closely allied to the long-winged forms of the old world genus *Dyrmadusa*, but the more slender posterior femora, narrower tegmina, more slender form, and the presence of distinct lateral carinæ on the posterior portion of the pronotum will serve to separate it from that genus.

The species of *Capnobotes* are probably all nocturnal, living among low, stunted vegetation. The notes given under *C. occidentalis* will probably be found to be true of all the species of the genus.

Three species and two varieties of *Capnobotes* are recognized and may be separated by the following table:

KEY TO THE SPECIES OF CAPNOBOTES.

A. Elytra marked along the disk with oblique light-colored spots and apically broad, 5 mm. from the tip being distinctly more than one-half as broad as at the broadest point (fig. 20).

B. Larger. Wings deeply fuliginous. Cerci of the male six or seven times as long as the basal breadth and armed on the inner side with an apical and a subapical tooth, subequal in size (fig. 22) ..... *fuliginosus*, p. 311

B′. Smaller. Wings hyaline, or slightly fuliginous in the costal area. Cerci of the male about four times as long as the basal breadth and armed on the inner side with a short, blunt apical tooth, sometimes reduced to a mere shoulder, and a longer subapical tooth (fig. 23).

C. Color brown or fawn colored ..... *occidentalis*, p. 315

C′. Color green or greenish.

D. Elytra uniformally green ..... *occidentalis* var. *uniformis*, p. 317

D′. Elytra green, with a row of light-colored discal spots. *occidentalis* var. *viridis*, p. 316

A′. Elytra nearly uniformly brown and apically very narrow, 5 mm. from the tip being considerably less than one-half as broad as at the broadest point (fig. 24) ..... *bruneri*, p. 317

CAPNOBOTES FULIGINOSUS Thomas.

Locusta fuliginosa Thomas, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, pp. 443–444, pl. 1, fig. 9; Rept. U. S. Geol. Surv. W. 100 Mer., V, 1875, p. 906.—Glover, Ill. N. A. Ent., Orth., 1872, pl. IX, fig. 9.—Riley, Stand. Nat. Hist., II, 1884, p. 191.—Howard, Ins. Book, 1901, pl. XXXV, fig. 6.

Capnobotus fuliginosus Scudder, Can. Ent., XXIX, 1897, p. 74; Cat. Orth. U. S., 1900, p. 76.—Caudell, Proc. U. S. Nat. Mus., XXVI, 1903, p. 806.—Rehn, Proc. Acad. Nat. Sci. Philad., 1904, p. 573.—Cockerell, The Ent., XXXVII, 1904, p. 180.—Kirby, Syn. Cat. Orth., II, 1906, p. 181.

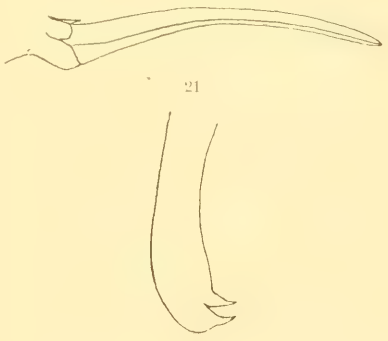
Description.—Head moderate, scarcely broader than the anterior portion of the pronotum into which it is inserted quite deeply; fastigium narrow, about as broad as the basal joint of the antenna, moderately prominent and very shallowly sulcate above; eyes moderately large and quite prominent, a little longer than broad; antennæ long and slender, the basal segment large, subquadrate. Pronotum

of medium size, posteriorly produced well over the base of the abdomen; lateral lobes well developed, nearly as deep as long not including the backward prolongation of the disk, quite strongly declivent, behind strongly sinuate, the humeral angle deep; lateral carinæ scarcely indicated on the anterior half and distinct and moderately sharp on the posterior half where they are slightly divergent; median carina scarcely indicated; disk transversely rounded in front but flat be-

FIG. 20.—CAPNOBOTES FULIGINOSUS, ADULT MALE.

hind, longitudinally nearly straight or gradually and slightly elevated posteriorly and anteriorly, being subhastate, usually cut across the anterior fifth by a distinct sulcus, curving forward below, meeting the anterior margin about halfway down the side; anterior margin truncate, posterior margin broadly rounded. Prosternal spines slender, long, and sharp. Elytra fully developed (fig. 20), extending about one-fourth their length beyond the tips of the posterior

femora, the right one in the male with an oval transparent membrane at the base on the tympanum, a similar oval area on the left elytron but there coraceous like the rest of the surface; wings about as long as the elytra, the anal field not produced beyond the general outline; veins quite heavy and the space next the costal vein somewhat thickened. Legs moderately long and slender; anterior coxal spines long and sharp, slightly curved; anterior femora longer than the pronotum and rounded, unarmed above, broadly sulcate below, with several spines on the inner margin and on the outer margin with a few very obscure blunt spines or usually with black tubercles or dots representing them; middle femora like the anterior ones except the spines are distinct on both margins below; posterior femora about four times as long as the pronotum, swollen in the basal half where they are about three times as broad as apically, rounded and unarmed above, below broadly sulcate and armed on both margins in apical three-fourths with about half a dozen short distinct and sharp spines; anterior femora armed below with several distinct spines on the inner margin, the outer margin unarmed or with a few acute tubercles, rarely, if ever, with distinct spines; anterior tibiæ armed below on both margins and above on the outer margin with three to five spines and on the inner margin above with none to two spines; middle and hind tibiæ armed above and below on both margins with several long spines, those of the posterior tibiæ below, except near the tip, alternate and quite remote from each other; plantula short, not quite one-half as long as the basal segment of the tarsus. Abdomen large and generally fairly plump, slightly carinate above, the last segment in both sexes long and furcate, each branch at least five or six times as long as the basal width; subgenital plate in both sexes moderately long and broad and apically notched, in the male furnished with a pair of apical styles about four or five times as long as the basal width; cerci long and slender, slightly exceeding the anal prolongation of the last abdominal segment in both sexes, simple and uniformly tapering to a sharp point in the female and in the male apically depressed and incurved, the apex divided into two short, stout, inwardly directed teeth with sharp naked points (fig. 22); ovipositor somewhat shorter than the posterior femora and curved moderately downward (fig. 21).



FIGS. 21, 22.—CAPNOBOTES FULIGINOSUS. 21, OVIPOSITOR. 22, CERCUS OF THE MALE.

General color brown variegated with lighter shades; head light brown with obscure postocular and occipital bands; pronotum light brown with

the upper part of the lateral lobes more or less infuscated and generally with dusky markings on the disk, the lateral carinae on the metazone generally black. Elytra light brown with ashy markings, the disk with a series of more or less distinct light diagonal spots; wings deeply fuliginous with translucent spaces between the cross veins over the greater part of the discal area. Legs yellowish brown with obscure darker mottlings on the femora, the posterior femora without scaliform markings on the outer face, sometimes longitudinally marked with a broken blackish line.

Measurements.—Length, pronotum, male, 7.5–8.5 mm., female, 7–9; posterior femora, male, 32–36, female, 32–38; elytra, male, 50–60, female, 56–68; cerci, male, 4–5, female, 3–4; ovipositor, 28–34; width pronotum across matazona, male, 5–6.25, female, 6–6.5; posterior femora, at widest point, male, 3.75–4.5, female, 3.75–4.75; elytra, across basal fourth, male, 9–11.5, female, 10–11; elytra 5 from apex, male, 7–10, female, 7–8; ovipositor at the middle, 1.75–2.25.

Type.—Cat. No. 1102, U. S. National Museum.

Specimens examined.—The type, a male collected in northern Arizona by Doctor Palmer, four males and four females from Arizona, Nevada, and California, one male taken by Townsend, probably in New Mexico, and a female from Lower California. Besides these, all of which are in the U. S. National Museum collection, I have seen specimens from Arizona and California in the collections of Scudder, Bruner, and Morse.

This species was described by Thomas in the genus *Locusta* from a single male which was figured.[a] Three years after the description of the male, Thomas described the female from a specimen collected by the Wheeler expedition. In 1897 Doctor Scudder erected the genus *Capnobotes* for this species and its allies. Being the first species described as well as the first to appear, both in table and discussion, in Scudder's article establishing the genus *Capnobotes*, it is logically the type of that genus.

This species seems to occur as adults in July and August, and probably later. The series studied, including material from the Scudder and Morse collections, exhibits considerable variation in the slenderness of the elytra, length of the ovipositor, and amount of the posterior elevation of the pronotum. But the different phases of development in these characters seem to extend throughout the range of the species and probably do not indicate specific differences. No specific differences were found to separate the Lower Californian specimen from those of California or Arizona.

Aside from Riley's statement in the Standard Natural History that they live in low and somber-colored vegetation, there is nothing

[a] Glover's Ill. North Amer. Ent., Orth., pl. IX, fig. 9.

recorded regarding the habits of this species. The habits are probably similar to those of *occidentalis* as discussed under the treatment of that species.

CAPNOBOTES OCCIDENTALIS Thomas.

Locusta occidentalis Thomas, Ann. Rept. U. S. Geol. Surv. Terr., V. 1872, p. 444, pl. II, fig. 16.—Glover, Ill. N. A. Ent., Orth., 1872, pl. XI, fig. 16.—Riley, Stand. Nat. Hist., II, 1884, p. 191.

Capnobotes occidentalis Scudder, Can. Ent., XXIX, 1897, p. 74; Cat. Orth. U. S., 1900, p. 76.—Woodworth, Bull. No. 142, Calif. Exp. Station, 1902, p. 15.—Cockerell, The Ent., XXXVII, 1904, p. 179.—Kirby, Syn. Cat. Orth., II, 1906, p. 182.

Description.—Much smaller than *fuliginosa* and very distinct from that species. Head and pronotum essentially as in *fuliginosa*, except that the pronotum is scarcely at all elevated posteriorly, while this is only true of some specimens of *fuliginosa*. Legs as in *fuliginosa*, the anterior femora with a few short spines on the inner inferior carina, the outer margin unarmed or sometimes with infuscated spots representing spines, in the nymphs with more distinct spines. Elytra generally more slender than common in *fuliginosa*, but with the same general color pattern, the oblique discal spots seemingly a little less elongate; wings shaped as in *fuliginosa*, but differing radically from those of that species in being transparent instead of fuliginous, the costal border only subopaque. Last abdominal segment with the anal prolongations not quite as elongate as in *fuliginosa*, at least in the male; cerci of the male much shorter than those of *fuliginosa*, being about four times as long as the basal breadth and apically armed on the inner side with a very short blunt spur, often a mere shoulder, and subapically with a long well-developed tooth or spur (fig. 23). Ovipositor curved gently downward and somewhat variable in length.

Fig. 23.—Capnobotes occidentalis, cercus of the male.

Color similar to that of *fuliginosa*, but usually more bleached in cabinet specimens, being of a fawn color. The wings are nearly transparant, not fuliginous as in *fuliginosa*. There are two color varieties, both green.

Measurements.—Length, pronotum, male, 6.5–7 mm., female, 7–7.5; elytra, male, 41, female, 45–55; wing, male, 37, female, 42–47; posterior femora, male, 26, female, 26–31; ovipositor, 22–27; width, pronotum across metazona, male, 4, female, 4.5–5; elytra at widest part, male, 7.5, female, 8; elytra 5 from apex, male, 4.5, female, 5.25; wing at widest point, male, 17, female, 20; ovipositor at middle, 1.5.

Type.—Cat. No. 1103, U. S. National Museum.

Specimens examined.—The type, a female from California taken by Mr. Taylor, two females from Salmon Falls, Idaho (Evermann), and a

male from Reno, Nevada (Wickham), taken in July. This male and also an immature male from Arizona (Dunn) were presented by Professor Bruner.

The nymph mentioned above has the characters of the adult, the wings, however, being short and reversed, and the spines on the outer carina of the lower side of the anterior femora are distinct. Bruner has a pair from Garfield Beach, Utah, and the Scudder collection contains a single female from Nevada, an unusually large specimen, from which I secured the above maximum measurements.

The following notes on the habits of this species are extracted from an article by Cockerell.[a]

> This species, also the variety *viridis*, was taken near Pecos, New Mexico, on dry hillocks covered with *Pinus edulis* and *Sabina sp.* The males commence to stridulate at dusk, and the note is so high pitched as to be inaudible to some persons. The insects were present in some numbers, but were very difficult to capture, jumping off into the darkness at the least disturbance.

CAPNOBOTES OCCIDENTALIS var. VIRIDIS Cockerell.

Capnobotes occidentalis var. *viridis* COCKERELL, The Entom., XXXVII, 1904, p. 180.—KIRBY, Syn. Cat. Orth., II, 1906, p. 182.

Description.—Similar to typical *occidentalis* except that the color is greenish instead of brown or fawn colored. The elytra have the row of light oblique discal spots as found in the typical form. The cerci of the only male seen, the type, has the apical inner tooth wholly aborted. The costal margin of the wings is greenish, the rest hyaline. The ovipositor of the only female examined, one received from Professor Bruner, is shaped as usual in the genus, and is as long as the posterior femora.

Measurements.—Length, pronotum, male, 6.5 mm., female, 7.5; elytra, male, 39, female, 49; posterior femora, male, 23, female, 30; ovipositor, 29; width, pronotum across the metazona, male, 4.5, female, 5; elytra at widest part, male, 7, female, 9; elytra 5 from apex, male, 4, female, 5; posterior femora at widest part, male, 3.25, female, 3.75; ovipositor in the middle, 1.75.

Type.—Cat. No. 10165, U. S. National Museum.

Specimens examined.—Two specimens, the type, a male from Pecos, New Mexico, presented by Cockerell, who took it on Pine, August 24, and a female without label from the Bruner collection.

This is probably the insect mentioned by Riley in the Standard Natural History as a green form of *C. fuliginosa* occurring in Utah. But the cerci of the male and the hyaline wings of both sexes at once separate this insect from *fuliginosa*. Besides, it is found associated with typical *occidentalis* as stated under that species.

---

[a] The Entomologist, XXXVII, 1904, pp. 178–181.

CAPNOBOTES OCCIDENTALIS var. UNIFORMIS, new variety.

Description.—Male, female unknown—very like the preceding form, but the color is uniformly greenish, the elytra without the usual row of oblique spots along the disk. The elytra are also considerably less elongate than in var. *viridis*, giving the insect quite a different appearance. The cerci are essentially like those of *viridis*.

Measurements.—Length, pronotum, 6.75 mm.; posterior femora, 26; elytra, 42; width, pronotum across the metazona, 4.5; elytra at widest part, 7.5; elytra 5 from apex, 5.25: posterior femora at widest point, 3.25.

Type.—Cat. No. 10166, U. S. National Museum.

Specimens examined.—One male, Los Angeles County, California, July. (Coquillett.)

This insect is described as a variety of *occidentalis* with considerable doubt. The uniform color and less slender elytra give it a very distinctive appearance and when more material from the west is studied it may prove to be a distinct species. The form of the elytra is very like that of *Anoplodusa arizonensis* Rehn.

CAPNOBOTES BRUNERI Scudder.

Capnobotes bruneri Scudder, Can. Ent., XXIX, 1897, p. 74; Cat. Orth. U. S., 1900, p. 76.—Woodworth, Bull. No. 142, Exp. Sta. California, 1902, p. 15.—Cockerell, The Ent., XXXVII, 1904, p. 181.—Kirby, Syn. Cat. Orth., II, 1906, p. 181.

Description.—Female, male unknown. Most closely allied to *fuliginosa*. General color a uniform wood brown; head and pronotum as in *fuliginosa*. Elytra unique in the genus, being more than twice as broad across the basal fourth than the apical fourth and nearly uniformly brown, the row of oblique discal spots scarcely noticable (fig. 24); wings fuliginous in heavy reticulations, not so opaque as in *fuliginosa* nor so transparent as in *occidentalis*, comparatively broader than in *fuliginosa*. All the femora spined beneath on both sides for the greater part of the length with short stout spines; anterior tibiæ armed above on the outer side only with three or four spines, the type having three on one tibia and four on the other. Ovipositor long and slender, longer than the posterior femora and curved downward as in the other species of the genus.

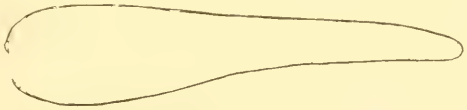


Fig. 24.—Capnobates bruneri. outline of elytron of the female. [type-specimen.]

Measurements.—Length, pronotum, 8.5 mm.; elytra, 47; wing, 41; posterior femora, 33; ovipositor, 37; width, pronotum across metazone, 5.5; elytra, at widest part, 10 mm.; elytra 5 from apex, 3.75; wing at broadest point, 20.5.

Type.—Cat. No. 10167, U. S. National Museum.

Specimens examined.—One female, Tepusquet Peak, Santa Barbara County, California. This specimen, Scudder's original type, is in the collection of the National Museum through the courtesy of Bruner. The very unusual shape of the elytra (fig. 24) and the coloration make this species easy of identification.

ANOPLODUSA, new genus.

Description.—Male, female unknown. Head of moderate size; eyes nearly round, quite prominent; vertex flat, not prominent, about the size of the basal segment of the antennæ. Pronotum posteriorly produced over the base of the wings as in *Capnobotes* and in shape agreeing with that of *C. fuliginosa;* prosternum unarmed, no sign of spines being present. Wings and elytra fully developed, extending beyond the tips of the posterior femora and shaped as in *Capnobotes fuliginosa*, the right elytron with transparent speculum, that of the left elytron opaque. Legs long, anterior and intermediate femora as long or a little longer than the pronotum; posterior femora about four times as long as the pronotum, abruptly and considerably swollen on the basal half and unarmed; anterior femora armed below with a few fine teeth on the inner margin, the outer margin unarmed; anterior tibiæ armed above on the outer margin only with three spines; otherwise the legs are essentially the same as in *Capnobotes*. Genitalia as in *Capnobotes*, the cerci of the only species known with two preapical teeth on the inner side.

Type.—Drymadusa arizonensis Rehn.

This genus bears a very striking resemblance to *Capnobotes*, having long wings and the same general appearance of the members of that genus. But the unarmed prosternum and the posterior femora being without ventral spines will readily separate it from that genus. *Anoplodusa*, lacking as it does prosternal spines, is not as nearly allied to *Drymadusa* as is *Capnobotes*.

There is but one species of this interesting genus.

ANOPLODUSA ARIZONESIS Rehn.

Drymadusa arizonesis Rehn, Proc. Acad. Nat. Sc., Philad., 1904, p. 573.—Kirby, Syn. Cat. Orth., II, 1906, p. 180.

Mr. Rehn's original description is here given in full:

Description.—Male, female unknown. Size rather large; form considerably elongate. Head with the occiput rounded transversly, not elevated, sloping gradually to the rather narrow, partially sulcate fastigium, which latter is deflected and touches the frontal process, width of the fastigium less than that of the first antennal joint; eyes wide apart, prominent, subglobose; antennæ as long as the tegmina. Pronotum selliform; anterior margin shallowly emarginate, posterior margin broadly and evenly rotundate; lateral lobes with the inferior margin rather narrowly rounded; posterior sinus very slight. Tegmina elongate, exceeding the apex of the abdomen by half their length, the greatest width is contained six and one-half times in the length, apex obliquely truncato-rotundate, costal expansion regular but not marked, greatest

basally and narrowing gradually toward the apex; wings equal to the tegmina in length. Abdomen somewhat compressed; supra-anal plate triangular, deeply and very narrowly divided into two elongate acute lobes; cerci rather short, the apical portion with two distinct hooks on the internal face; subgenital plate compressed, deep, inferiorly carinate, apical margin triangularly incised. Anterior femora longer than the pronotum, internal inferior margin with three to four very distinct spines; tibiæ with two spines on the external superior margin. Median femora slightly longer than the anterior, external inferior margin with one or two spines; tibiæ with two spines on the external superior margin and three internal superior margin. Posterior femora slightly shorter than the head and body, apical half slender and subequal, basal half moderately expanded; tibiæ slightly longer than the femora, compressed quadrate in section, regularly spined above, except basally, where the spines are fewer, inferior face with seven pairs of spines and several odd ones, upper inner calcar much exceeding the external in size; posterior tarsi of the type usual in the genus (*Drymadusa*).

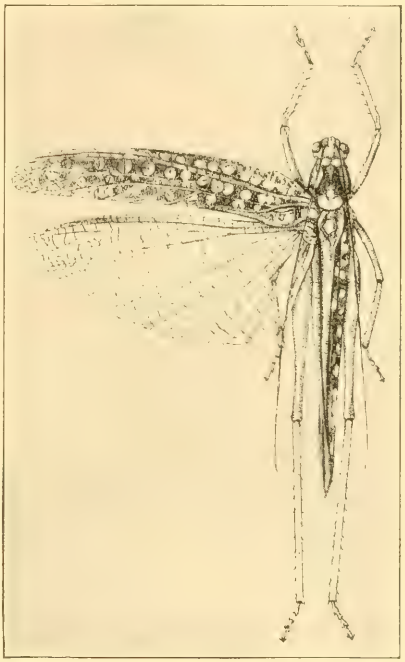


FIG. 25.—ANOPLODUSA ARIZONENSIS. ADULT MALE.

General color ochraceous buff (probably greenish in life), washed with apple-green on the tegmina. Head darker above than below; eyes hazel. Pronotum with an hourglass-shaped figure on the median portion of the disk, and a line along the posterior portion of the lateral lobes approximately parallel to the margin blackish-brown; posterior margin of the disk of the pronotum basally bone-white. Tegmina with a distinct median longitudinal series of subcircular opaque whitish spots, flanked above by a short series not so distinct, a few poorly defined blotches along the anal margin, and an irregular jumbled series in the costal field.

Measurements.—Length, body, 29 mm.; pronotum, 6.8; tegmina, 41; posterior femora, 24.5; width, pronotum at widest point 5; tegmina at widest point, 6.5.

Type.—In the Academy of Natural Sciences, of Philadelphia.

Specimens examined.—The type (fig. 25), a male from Florence, Pinal County, Arizona, 1903 (C. R. Beiderman).

Mr. Rehn's statement that the anterior tibiæ have but two dorsal spines on the outer margin is wrong, there being three of them. In the above description the name supraanal plate is used for what I call the last abdominal segment.

The cerci of this species are shaped essentially like those of *Capnobotes fuliginosa* (fig. 22), and extend to the tip of the last abdominal segment.

In the Scudder collection is an immature dectician without label, neither date nor locality, but presumably from the United States as it is associated with other material belonging to our fauna. It is a female, and by the development of reversed and elongately pointed wing pads is obviously the young of some long-winged species. The prosternum is unarmed, and the ovipositor is distinctly curved upwards. These characters prohibit its reference to *Capnobotes*, and so, unless it is some foreign species mixed in with the native forms, it is probably a nymph of the present species. If so, the ovipositor of *Anoplodusa* is seen to be curved upwards instead of downwards as in *Capnobotes*.

ATLANTICUS Scudder.

Engoniaspis Brunner, Ann. Mus. Civ. Stor. Nat. Genova, XXXIII (2d ser., XIII), 1893, p. 185 (invalid, no species included).—Scudder, Can. Ent., XXVI, 1894, pp. 177, 179 (invalid, no species included).—Guide N. A. Orth., 1897, p. 56 (invalid, no species included).—Cat. Orth U. S., 1900, pp. 75, 96.—Kirby, Syn. Cat. Orth., II, 1906, p. 181.

Atlanticus Scudder, Can. Ent., XXVI, 1894, pp. 177, 179.—Guide N. A. Orth., 1897, p. 55; Cat. Orth. U. S., 1900, p. 75.—Blatchley, Orth. Ind., 1903, p. 392.—Kirby, Syn. Cat. Orth., II, 1906, p. 181.

Description—Head of medium size, not prominent; eyes nearly round, moderately prominent; vertex moderately prominent, about one-third as broad as the interocular space. Pronotum large, posteriorly much produced over the base of the abdomen; disk broadly rounded, posterior margin rounded or subtruncate, anterior border truncate; lateral lobes well developed, but not so deep as long, separated from the disk by sharp and persistent lateral carinæ, in one species less sharp but still distinct; median carina absent or bluntly indicated on the posterior margin. Prosternum armed with two spines, usually long and sharp, but sometimes shorter and less acute. Elytra rudimentary and wholly concealed beneath the pronotum in the female; in the male strongly convex and projecting somewhat beyond the pronotum and overlapping above. Legs moderately stout; posterior femora variable in length, varying according to species, much and abruptly swollen on the basal half and unarmed, or armed below on the inner carina with a few short spines; anterior tibiæ armed above on the outer carina only with three spines; posterior tibiæ furnished below with four apical spurs. Subgenital plate apically deeply cleft in the female, in the male very shallowly cleft and terminated by a pair of oblong rounded styles; supraanal plate small, triangular and apically more or less broadly rounded in both sexes, usually inconspicuous; cerci rounded in both sexes, simple in the female, in the male armed on the inner side with a tooth; ovipositor straight or, in one species, sometimes curved gently upwards.

Type.—Decticus pachymerus Burmeister.

This genus bears a striking superficial resemblance to the European genus *Thyreonotus*, but is not systematically related to it, having four instead of two apical spurs beneath the posterior tibia. That the genus *Engoniaspis* of Brunner is a synonym of *Atlanticus* is very certain, a figure of the type of the former genus, a female, having been sent to me by Brunner. This figure (fig. 29) shows very clearly that it is an *Atlanticus* and quite certainly *A. pachymerus*.

Engoniaspis Brunner would invalidate the later described *Atlanticus* of Scudder had it been based on a named species, but it remained invalid until the establishing of *Atlanticus* in 1894.

The species of *Atlanticus* occur east of the great plains from Canada to the southern States in the South, probably extending westward to California. So far as known they inhabit open woodlands or dry hillsides, sometimes however being found in marshy meadows. They are sometimes called "shield-back grasshoppers" and occur from early spring, when the young nymphs issue and hop about in the woods and along hillsides, till late in September in the Middle States, when the last of the slowly moving adults are seen. Blatchley says that in Indiana they reach maturity in June.

In confinement these insects will eat animal as well as vegetable food, and in nature probably do not confine themselves to a vegetable diet. The young are active all day, and many fall a prey to insectiverous birds and reptiles. The adults also hop about during the day, and the males stridulate by day as well as by night.

There are three described species of this genus. These are separable as follows:

KEY TO THE SPECIES OF ATLANTICUS.

A. Lateral carinæ of the pronotum sharp. Cerci of the male with a short stout tooth situated about or beyond the middle on the inner side.

B. Posterior femora long, more than two times as long as the pronotum. Elytra in the male projecting beyond the pronotum a distance less than the width of the pronotal disk at the anterior margin. Cerci of the male with that portion beyond the inner tooth three times as long as the basal width..... *dorsalis*, p. 321.

B′. Posterior femora shorter, less than or scarcly two times as long as the pronotum. Elytra of the male projecting beyond the pronotum a distance equal to or greater than the width of the pronotal disk at the anterior margin. Cerci of the male with that portion beyond the inner tooth about two times as long as wide..... *pachymerus*, p. 323.

A′. Lateral carinæ of the pronotum distinct but not sharp. Cerci of the male with a long slender tooth situated much before the middle on the inner side..... *gibbosus*, p. 326.

ATLANTICUS DORSALIS Burmeister.

Decticus dorsalis BURMEISTER, Handb. Ent., II, 1838, p. 713.

Locusta (Ephippigera) dorsalis DE HAAN, Bijdr. Kenn. Orth., 1842, p. 178.

Thyreonotus dorsalis SCUDDER, Bost. Journ. Nat. Hist., VII, 1862, p. 454.—HITCHCOCK, Rept. Geol. N. H., 1, 1874, p. 370; Proc. Bost. Soc. Nat. Hist., XIX,

1877, p. 83; Ent. Notes, VI, 1878, p. 24.—Walker, Cat. Derm. Salt. Orth. Brit. Mus., II, 1869, p. 246.—Smith, Rep. Conn. Bd. Agric., 1872, (1872) p. 380; Cat. Ins. N. J., 1890, p. 411.—Comstock, Intr. Ent., 1888, p. 118.—Fernald, Ann. Rept. Mass. Agric. Coll., XXV, 1888, p. 110.—Orth. N. E., 1888, p. 26.—Davis, Ent. Amer., V, 1889, p. 80.—Blatchley, Proc. Ind. Acad. Sci., 1892, (1894) pp. 151–152.

Atlanticus dorsalis Scudder, Can. Ent., XXVI, 1894, pp. 179, 180, 183.—Cat. Orth. U. S., 1900, p. 75.—Psyche, IX, 1900, p. 104.—Beutenmuller, Bull. Amer. Mus. Nat. Hist., VI, 1894, p. 285, pl. vi, fig. 8.—Blatchley, Orth. Ind., 1897, p. 23.—Smith, Ins. N. J., 1900, p. 162.—Kirby, Syn. Cat. Orth., II, 1906, p. 181.

Description.—Head of moderate size, not swollen, quite deeply set into the pronotum; fastigium broader than the basal segment of the antenna, about one-third as broad as the interocular space; front transversely convex; eyes moderate, nearly round and moderately prominent; antennæ long and slender, basal segment large, broad and strongly depressed. Pronotum large, posteriorly much produced, in the female entirely covering the wings; lateral lobes well developed but scarcely as deep as long, slanting moderately outward, the posterior margin distinctly sinuous; lateral carinæ sharp and distinct, converging very moderately in the anterior fifth and then considerably expanding to the posterior margin of the pronotum; median carina absent or very dimly present posteriorly; pronotal disk slightly convex, the anterior margin truncate, posterior margin broadly rounded, marked just behind the middle with a broad, shallow, transverse sulcus, sometimes scarcely visible; behind this transverse sulcus the surface is not so smooth as anteriorly. Prosternal spines of variable lengths but always present and well developed. Legs stout; anterior coxal spines sharp, slightly recurved and basally flattened; posterior femora more than two times as long as the pronotum, much swollen on the basal half and usually armed below on the inner carina with a few small spines, sometimes unarmed; posterior and intermediate tibiæ armed above and below on both margins; anterior tibiæ armed above on the outer margin only with three spines and on both margins below with several spines. Organs of flight completely concealed beneath the pronotum in the female, in the male overlapping above and projecting beyond the pronotum a distance usually less than the anterior width of the pronotum, the tympanum well developed but mostly concealed beneath the posterior portion of the pronotum. Supraanal and subgenital plates and the cerci of the female as described under the genus; cerci of the male armed about the middle on the inner side with a short stout spine, that portion of the cercus beyond the tooth about three times as long as the basal width; ovipositor straight, shorter, or rarely as long or a little longer, than the posterior femora, the lower margin straight, the upper margin obliquely cut off apically, bringing the organ to a moderately sharp point (fig. 26).

General color quite uniformly brownish, the posterior margin of the lateral lobes of the pronotum sometimes, but not always, yellowish

white and the posterior portion next the lateral carinæ sometimes darkened. The tips and outer face of the posterior femora are sometimes infuscated and the whole insect is often more or less blotched with blackish, but never conspicuously so.

Measurements.—Length, pronotum, male, 8–10 mm., female, 10.5–12; posterior femora, male, 19–22, female, 26–30; ovipositor, 22–30; width, pronotum at widest point, female, 6.5–7.5; ovipositor in middle, 1.5–1.75.

Specimens examined.—Immature specimens of what I believe to be this species are in the National Museum from Arizona, Florida, Virginia, and Maryland, and adults from Maryland, Virginia, District of Columbia, Mississippi, and Florida. This species has been recorded from New England to Florida and westward to Indiana. It has not been recorded from west of the Mississippi River. In my notebook, however, is mention of a female nymph in the Morse collection from California. On March 4, 1904, Dyar took a nearly full-grown male nymph at Jacksonville, Florida, in which the disk of the pronotum has the lateral carinæ nearly parallel. It was found in a damp woods and jumped into a pool of water, thus facilitating its capture. I have taken nearly full-grown nymphs in Maryland on July 7, sitting on a low bush at dusk. The young are locally quite common in the vicinity of Washington during April, but the adults are, as a rule, quite rare. The young nymphs have the prosternal spine but little developed.

FIG. 26.—ATLANTICUS DORSALIS. TIP OF THE OVIPOSITOR.

Mr. Lutz took a female on Long Island, New York, on October 16, which he considered as approaching quite closely the allied *A. pachymerus*, and questions the distinctness of these two species. But the measurements given in his notes[a] fall within the range presented by *dorsalis*.

ATLANTICUS PACHYMERUS Burmeister.

Decticus pachymerus BURMEISTER, Handb. Ent., II, 1838, p. 712.

Locusta (Ephippigera) pachymerus DE HAAN, Bijdr. Kenn. Orth., 1842, p. 178.

Thyreonotus pachymerus SCUDDER, Bost. Journ. Nat. Hist., VII, 1862, p. 453.—WALKER, Cat. Derm. Salt. Orth. Brit. Mus., II, 1869, p. 246.—SMITH, Rept. Conn. Bd. Agric., 1872 (1872), p. 380; Cat. Ins. N. J., 1890, p. 411.—COMSTOCK, Intr. Ent., 1888, p. 118, fig. 106.—FERNALD, Ann. Rept. Mass. Agric. Coll., XXV, 1888, p. 110; Orth. N. E., 1888, p. 26.—DAVIS, Ent. Amer., V, 1889, p. 80; Can. Ent., XXV, 1893, pp. 108–109.—MCNEILL, Psyche, VI, 1891, p. 24.—OSBORN, Proc. Iowa Acad. Sci., I, Pt. 2, 1892, p. 119.—BLATCHLEY, Proc. Ind. Acad. Sci., 1892 (1894), pp. 150–151.—GARMAN, Orth. Ky., 1894, p. 7.

Atlanticus pachymerus SCUDDER, Can. Ent., XXVI, 1894, pp. 179, 180, 183; Cat. Orth. U. S., 1900, p. 76; Psyche, IX, 1900, p. 104.—BEUTENMÜLLER, Bull. Mus. Amer. Nat. Hist., VI, 1894, p. 285, pl. VII, fig. 7.—DAVIS, Journ. N. Y. Ent. Soc., III, 1895, p. 142.—BLATCHLEY, Orth. Ind., 1897, p. 23.—LUGGER, Orth. Minn., 1898, p. 245, fig. 160.—SMITH, Ins. N. J., 1900, p. 162.—HENSHAW, Psyche, IX, 1900, p. 119.—KIRBY, Syn. Cat. Orth., II, 1906, p. 181.

[a] Ent. News, XVI, 1900, pp. 201–202.

Pterolepis pachymerus BALL, Proc. Iowa Acad. Sci., IV, 1897, p. 237.
Decticus derogatus WALKER, Cat. Derm. Salt. Orth. Brit. Mus., II, 1869, p. 260.
Engoniaspis testacea SCUDDER, Cat. Orth. U. S., Append., 1900, p. 96.—KIRBY, Syn. Cat. Orth., II, 1906, p. 181.

Description.—Of the same general color and appearance as *A. dorsalis*, but the posterior femora are usually less than two times as long as the pronotum, rarely twice as long, or a little more (fig. 27), and the ovipositor is generally longer than the posterior femora rather than shorter, as in *dorsalis*. The posterior margin of the pronotum is usually less rounded than in *dorsalis*, sometimes subtruncate. The elytra of the males are better developed, as a rule, than those of *dorsalis*, projecting beyond the pronotum a distance equal to or greater than the anterior width of the pronotal disk. The cerci of the male are similar to those of *dorsalis*, except that the inner tooth is less remote from the apex, that portion of the circus beyond the tooth being scarcely more than two times as long as the basal breadth. (See fig. 30.)

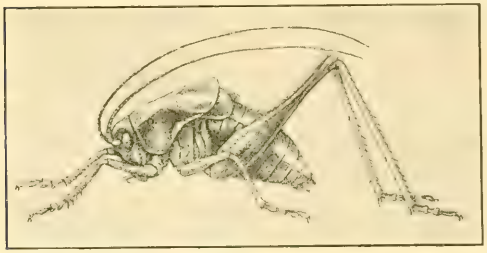


FIG. 27.—ATLANTICUS PACHYMERUS. ADULT MALE.

Measurements.—Length, pronotum, male, 8.5–11 mm., female, 8–10; posterior femora, male, 15–18, female, 16–22; ovipositor, 17–22; width, pronotum across anterior portion, male, 3.25–3.75, female, 3.75; pronotum across posterior portion, male, 6–8, female, 6.5–6.75.

Type.—Cat. No. 5734, U. S. National Museum.

Specimens examined.—National Museum material from Ohio, District of Columbia, Virginia, Maryland, North Carolina, Indiana, and the type of *Engoniaspis testacea* presumably from Missouri; also material from various localities in the collections of Scudder, Brunner, and Morse.

FIG. 28.—ENGONIASPIS TESTACEA. TYPE SPECIMENS (DOTTED PORTIONS RESTORED).

This species does not usually extend as far south as *dorsalis*, the southern limit, so far as recorded, being North Carolina, but is found as far north as Canada.[a] It has been recorded from the Mammoth Cave in Kentucky, but probably erroneously so, as it is not a cave species.

The type of *Engoniaspis testacea*, as stated in Scudder's original

[a] Blatchley, in A Nature Wooing by the Sea, records it from Florida, the record being based upon nymphs. These immature specimens may belong to another species.

description, is without the tip of the abdomen, but it is certainly a female, as shown by the absence of wings, fig. 28. It agrees in every particular, including the prosternal spines, with female specimens of authentic *A. pachymerus*, and I feel perfectly safe in establishing its synonomy with that species. Being the type of *Engoniaspis*, the only described species, it makes that genus a synonym of *Atlanticus*. Fig. 29 shows the insect upon which Brunner established the genus *Engoniaspis*. In his letter inclosing this drawing Brunner writes:

Of *Engoniaspis* I possess but two females. I send you a drawing. The thorns of the prosternum are pointed. The color of the animal is brown.

FIG. 29.—ENGONIASPIS, SPECIES. FIGURE OF TYPE FROM DRAWING SENT TO ME BY BRUNNER. (REDUCED ONE-HALF.)

The figure shows the straight ovipositor and general appearance of *pachymerus*. The imperfect type of Scudder's *E. testacea* is shown in fig. 28.

Like its congener this species is active by day as well as by night. I have taken the adult male in early September on Plummer's Island, Maryland, hopping about in open woods in the early afternoon. The young hatch early in the spring, in March or early April in the vicinity of Washington, and, like the young of *dorsalis*, are more active leapers than when matured. William Davis has an interesting account of this species in the Canadian Entomologist for 1893. He found the males stridulating in some numbers in a swampy meadow on Staten Island, New York. It was June 26, on a sunny afternoon. One male specimen was captured, sitting unconcealed on a dry dead leaf of swamp grass, and placed in a cage in Mr. Davis's room. Here it sang with unabated zeal until the first of August, when his song grew less in volume until finally he died on the tenth or eleventh of September. The song is described as resembling somewhat that of *Orchelimum vulgare* with the preliminary "zip, zip" omitted. "It was," says Mr. Davis, "a continuous 'zeee,' with an occasional short 'ik,' caused by the insect getting its wing-covers ready for action after a period of silence." This specimen grew quite tame, following the hand for fruit, with which it was liberally supplied, but at times took unnecessary fright and bumped its head against its prison walls in a most insane fashion. He did not usually hide at all but sat on a leaf in his prison, waving his long antennæ.

FIG. 30.—ATLANTICUS PACHYMERUS. CERCUS OF ADULT MALE.

Beutenmüller records this species as occurring in New York in dry places, especially along hillsides, from the middle of June to late September. The adults are unable to leap more than a few inches, especially the males, which usually have the posterior legs very short, often scarcely a third longer than the pronotum.

Future investigations may prove *pachymerus* to be a variety of *dorsalis*, but at the present state of our knowledge it can scarcely be considered other than as a distinct species. There is much variation in the development of the elytra and some in the relative length of the posterior femora. Rarely some females have the ovipositor distinctly curved upward, but usually it is straight or even slightly curved downward.

ATLANTICUS GIBBOSUS Scudder.

Atlanticus gibbosus Scudder, Can. Ent., XXVI, 1894, p. 180; Cat. Orth. U. S., 1900, p. 75.—Rehn, Proc. Acad. Nat. Sci. Philad., 1904, (1905), p. 797.—Kirby, Syn. Cat. Orth., II, 1906, p. 181.

Description.—Head moderately large, not swollen nor deeply inserted into the pronotum; fastigium broad, rounded, not sulcate, broader than the first segment of the antenna. Eyes moderate, not prominent; antennæ slender, basally enlarged. Pronotum large and produced posteriorly over the base of the wings more than usual in the other members of the genus, completely covering the wings in both sexes, lateral lobes but moderately deep, almost vertical, posteriorly broadly sinuate; lateral carinæ prominent but less acute than in the other species of the genus, converging on the anterior fourth and from there backward diverging and rounded outward, making the disk of the metazona very elongate-ovate, posteriorly well rounded, nearly semicircular; median carina absent or barely indicated on the posterior margin of the disk; pronotal disk broadly convex, without transverse sulci, the anterior margin truncate; prosternal spines elongate and moderately acute. Abdomen heavy, not or very slightly carinate above. Elytra and wings of both sexes concealed beneath the pronotum. Legs moderately stout; posterior femora much swollen on the basal half or a little more, genicular lobes well developed, forming close-lying laminæ, or flattened spines; anterior tibiæ armed above on the outer margin only with three spines; intermediate tibiæ spined above on both margins and the posterior ones armed with a double row of small equal closely set spines above on the apical two-thirds and below with a few small scattered spines on the median line only. Cerci of the female simple, conical, about four times as long as the basal width, of the male long and moderately stout, apically slender, curved inward and then upward quite strongly, near the base on the inner side armed with a long incurved tooth two times as long as the width of the cerci at that point (fig. 31); last abdominal segment rectangularly incised; ovipositor about one-fifth shorter than the posterior femora and straight.

Fig. 31.—Atlanticus gibbosus. Tip of abdomen of male from above.

General color a light yellowish, quite uniform except the lateral lobes of the pronotum, which are black on the upper half for the entire length.

Measurements.—Length, pronotum, male and female, 14 mm.; posterior femora, male, 32, female, 30; ovipositor, 24; cerci, male, 3.5–4.5, female, 2.5; width, pronotum at widest point, male and female, 8; posterior femora at widest point, male and female, 7, at narrowest point, male and female, 1.5.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

Specimens examined.—Four adult and two immature specimens from Florida and one male and two females from North Carolina.

The Scudder collection contains five specimens, two male nymphs from Florida and one male and two female adults from North Carolina. The above description was drawn up from the adults from North Carolina. The U. S. National Museum is indebted to the liberality of Professor Bruner for an adult male specimen of this species from Lake City, Florida.

This large southern species is a very noticeable form. The large and posteriorly rounded pronotum will serve to readily separate it from the other members of the genus. It superficially resembles the European *Thyreonotus corsicus*, but is not structurally allied to that species.

Immature individuals of this species were found by Mr. Rehn quite plentiful in southern Georgia. They were found in pine woods in March and April, probably maturing about July.

APOTE Scudder.

Drymaduza Scudder (not Stein), Can. Ent., XXVI, 1894, pp. 178–180.
Apote Scudder, Can. Ent., XXIX, 1897, p. 73.—Kirby, Syn. Cat. Orth., II, 1906, p. 182.

Description.—Head medium in size; eyes large and moderately prominent; vertex about one-fourth as broad as the interocular space. Pronotum long and narrow, posteriorly well produced over the base of the abdomen; disk rounded anteriorly and tectate posteriorly, the anterior margin truncate, the posterior margin semicircularly rounded; lateral lobes longer than high, the posterior margin slightly sinuate; lateral and median carinæ absent on the anterior portion of the pronotum, posteriorly present, the former parallel and blunt, the latter low but fairly sharp; prosternum armed with a pair of long sharp spines. Wings short but equally developed in both sexes, convex, overlapping above and projecting beyond the pronotum a distance less than the length of the pronotum. Legs stout; posterior femora short, less than two times as long as the pronotum, abruptly and considerably swollen on the basal half, or slightly more; anterior tibiæ armed above on the outer margin only with three spines; all the femora armed beneath on

both margins with small blunt spines, usually minute and fewer in number on the inner margin. Subgenital plate apically triangularly incised in the male, terminated by a pair of short blunt unarticulate styles, of the female less distinctly incised and without terminal styles; supraanal plate short and triangular in both sexes; cerci of the female short, conical, simple; of the male longer, cylindrical in the basal three-fourths, on the inner side furnished with a pointed projection (fig. 33); ovipositor more than two times as long as the pronotum and quite strongly curved downward.

Type.—*Apote notabilis* Scudder.

This genus is allied to the European genus *Drymadusa*, but differs in several particulars, more especially in the short posterior femora, less distinct humeral sinus, and the less distinct carinæ on the posterior portion of the pronotum. But one species is known.

APOTE NOTABILIS Scudder.

Drymadusa sp. SCUDDER, Can. Ent., XXVI, 1894, p. 180.
Apote notabilis SCUDDER, Can. Ent., XXIX, 1897, p. 73; Cat. Orth. U. S., 1900, p. 76.—KIRBY, Syn. Cat. Orth., II, 1906, p. 182.

Description.—Head moderately large and prominent, barely broader than the anterior portion of the pronotum, into which it is inserted

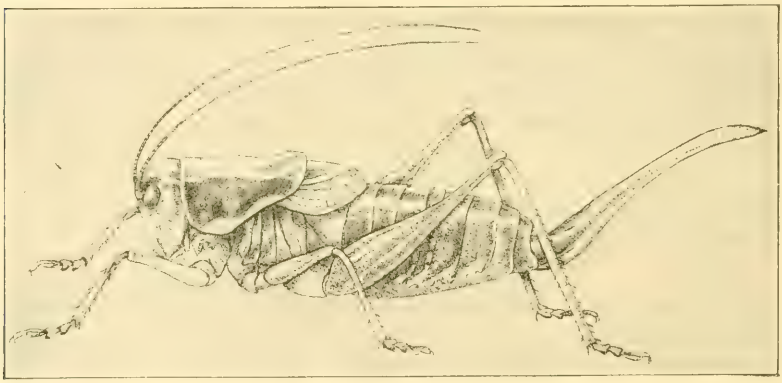


FIG. 32.—APOTE NOTABILIS. ADULT FEMALE.

quite deeply; vertex considerably broader than the basal segment of the antenna, but scarcely more than one-fourth as broad as the interocular space; front broadly rounded; eyes large and prominent, nearly round; antennæ long and slender, the basal segment broad and flattened. Pronotum large, elongate, narrow, posteriorly produced over the base of the abdomen; lateral lobes well developed, somewhat longer than high, the posterior margin nearly straight, the humeral sinus being feeble, but distinct; disk rounded and without carinæ on the anterior half or three-fourths, or very slightly indicated; behind that portion, and set off by a shallow transverse furrow, there is a

distinct and fairly sharp median carina, on each side of which the disk is flat and slanting to the distinct but very blunt lateral carinæ; the disk is no broader at one point than another, and has a second transverse sulcus near the anterior border, and just anterior of the post-median transverse furrow it is marked with a V-shaped depression, the apex directed backwards and nearly touching the transverse depression; prosternal spines long, erect, sharp. Legs and wings as described under the genus, the elytra narrowly rounded at the apex. Abdomen large and plump, sometimes obscurely carinate above. Cerci of the female simple, conical, about four times as long as the basal width, of the male more than four times as long as the basal width, and on the inner side toward the tip armed with a moderately slender sharp-pointed tooth, with the upper edge meeting the terminal part of the cercus at an angle (fig. 33), or a less slender tooth with the upper edge in a line with the tip of the cercus (fig. 34); ovipositor longer than the posterior femora, curved distinctly downward and slightly narrowed medially, the tip sharp and unarmed. (See fig. 32.)

FIG. 33.—APOTE NOTABILIS. CERCUS OF MALE.

Color, brown, marked with ash-gray; head, dark brown above, merging into yellow on the face and below; antennæ yellowish at the base, apically becoming darker; pronotum brownish above, sometimes varied with pale yellowish, the posterior margin of the lateral lobes also sometimes margined with yellow. Wings brownish, with black veins; abdomen brown, with pallid subdorsal lines and more or less mottled on the sides with the same color, below yellowish; pleura below the wings piceous with a pale border below. Legs yellowish, the outer face of the posterior femora usually more or less infuscated; ovipositor yellow with the tip margined with black.

FIG. 34.—APOTE NOTABILIS VAR. ROBUSTA. CERCUS OF MALE.

Measurements.—Length, pronotum, male, 10–13.5 mm., female, 10–13; elytra, male, 6–7, female, 5–6; posterior femora, male, 18–22, female, 19.5–22; cerci, male, 2.75–3, female, 1.75; ovipositor, 23–29; width, pronotum at posterior border, male and female, 5.5–7; posterior femora on basal half, male and female, 4–5, on apical half, male and female, 1.25–1.75.

Type.—In the Museum of Comparative Zoology.

Specimens examined: Material from North Dakota, Oregon, Washington, and Vancouver Island, British Columbia.

The National Museum contains one male and two females from the State of Washington, Rockland, July 4 (Fisher) and Pullman, June 25 (Piper), and one female from Wellington, British Columbia (Taylor). Two male and one female specimens were also sent to me for study by the Washington Experiment Station. These are from Pullman and

Washtucna, no dates given. Bruner's material, comprising five specimens, all females, from Washington, was also studied.

Besides the type, a single female from Dakota, the Museum of Comparative Zoology has a mature pair labeled as having been taken in Oregon in the month of June. This male has an intestinal worm, *Mermis sp.* protruding at least eight inches from the tip of the abdomen.

The dissimilarity of the cerci of the two males critically studied is indicative of two distinct forms. The form with cerci like fig. 34 is heavier and more robust in both sexes and the posterior femora seem broader. The lower margins of the lateral lobes of the pronotum are not pallid, as seems to be constantly the case with the other form, and the general color is apparently somewhat lighter. The habitat of the two forms are the same, however, and there are certain tendencies toward variation which make it seem best for the present to consider the two forms varietal rather than as distinct species. I therefore propose the varietal name *robusta* for the heavier form. The maximum of the above measurements are from this variety.

Type.—Cat. No. 10168 U. S. National Museum.

EREMOPEDES Cockerell.

Eremopedes Scudder, Can. Ent., XXVI, 1894, pp. 178, 181 (invalid, no described species included); Guide Orth. N. A., 1897, p. 56 (invalid, no described species included); Cat. Orth. U. S., 1900, pp. 78, 97; Proc. Davenp. Acad. Nat. Sci., IX, 1902, p. 55.—Cockerell, Ann. Mag. Nat. Hist. (7), II, 1898, p. 323.—Caudell, Can. Ent., XXXIII, 1902, p. 100.—Kirby, Syn. Cat. Orth., II, 1906, p. 192.

Description.—Head moderate in size; vertex narrow, one-half, or less, as broad as the interocular space except in *brevicauda*, where it is nearly as wide. Pronotum moderately large and well produced posteriorly, without carinæ, or with mere indications of lateral carinæ on the posterior margin in one species, or obscure but persistent in *brevicauda*. Lateral lobes of the pronotum well developed except in a single species. Prosternum typically unarmed, but there are in some species a pair of fairly distinct spines present in some specimens. Wings wholly concealed in the female, in one species a little exposed; in the male the elytra are broad, overlap above, and project somewhat beyond the pronotum. Legs moderately slender, the posterior femora more than two times as long as the pronotum and moderately to considerably swollen on the basal two-thirds; anterior tibiæ armed above on the outer margin only with three spines. Abdomen moderately large and plump, scarcely carinate, the terminal segment deeply cleft, especially in the male (fig. 37); supraanal plate small, triangular, deeply sulcate above in the middle, the whole nearly hidden beneath the last abdominal segment; cerci simple in the female, in the male more or less sinuate and with a blunt tooth-like projection on the inner side; ovipositor

curved moderately upward and somewhat shorter or a little longer than the posterior femora, in one species short and subfalcate.

Type.—Eremopedes scudderi Cockerell.

This genus seems to naturally unite those of our genera of Decticinæ having the prosternum unarmed with those having it armed. Some specimens of even the same species have the prosternum wholly unarmed, while others have a pair of short but moderately distinct spines. This makes some species almost indistinguishable from certain members of the previous genus, *Stipator*. Especially is this true of *Eremopedes balli*, which is difficultly separable from *Stipator stevensoni*, except by the cerci of the males. The extreme superficial resemblance of these two species is the cause of a queer blunder having been made.[a]

Eremopedes is very closely allied to *Idiostatus*, but presents several points of difference. The females of *Eremopedes* generally have the ovipositor more strongly curved upward, and the elytra are usually wholly concealed beneath the pronotum, while in *Idiostatus* they are more or less extended beyond the pronotum. The elytra of the males are usually shorter in *Eremopedes* and the lateral carinæ of the pronotum of both sexes are scarcely indicated, while in *Idiostatus* they are more or less distinct, especially posteriorly. The prosternum, so far as known, is never armed in *Idiostatus*, while it is sometimes in *Eremopedes*.

Doctor Scudder proposed the genus *Eremopedes* in the year 1894, but he based it upon an undescribed species, thus giving it no standing. The first species described under the genus was Cockerell's *scudderi*, and, according to rules covering such cases, that is therefore the type of the genus. Thus the genus is credited to Cockerell. This view is the opposite of that formerly held by me, but it seems the proper one, as otherwise many changes would result, such as the replacement of *Atlanticus* Scudder by *Engoniaspis* Brunner, etc.

There are five species of *Eremopedes*. They occur mostly in the southwestern United States and seem to be nocturnal in habit, hiding by day in nooks, under bark, etc. The species are separable by characters given in the following table, given for convenience in two parts, one for the males and one for the females:

KEY TO THE SPECIES OF EREMOPEDES—MALES.

A. Cerci shaped as fig. 37, projecting almost one-half their length beyond the last abdominal segment ..... *scudderi*, p. 333

A′. Cerci shaped as figs. 36 and 38, projecting but little beyond the last abdominal segment.

B. Smaller, pronotum 6 mm. or less in length; cerci shaped as fig. 38 .... *balli*, p. 335

B′. Larger, pronotum more than 6 mm. in length; cerci shaped as fig. 36. *ephippiata*, p. 332

The males of *brevicauda* and *albofasciata* unknown.

[a] See discussion under *Eremopedes balli*, p. 336.

KEY TO THE SPECIES OF EREMOPEDES, FEMALES.

A. Ovipositor long, more than two times as long as the pronotum.
B. Larger, the posterior femora 19 mm. or more in length, very rarely as little as 18 mm.
C. Ovipositor as long, or almost as long, as the posterior femora; lateral lobes of the pronotum not so well developed as in the alternating category, the posterior sinus less distinct.
D. Color variable but without dorso-lateral white stripes. . *scudderi*, p. 333
D′. Color green, conspicuously marked with a pair of dorso-lateral white stripes on the pronotum and abdomen ..... *albofasciata*, p. 337
C′. Ovipositor usually no more than two-thirds as long as the posterior femora; lateral lobes of the pronotum well developed, the posterior sinus distinct. *ephippiata*, p. 332
B′. Smaller, the posterior femora not over 18 mm. in length..... *balli*, p. 335
A′. Ovipositor short, no longer than the pronotum ..... *brevicauda*, p. 336

EREMOPEDES EPHIPPIATA Scudder.

Cacopteris ephippiata SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 88, 91.—KIRBY, Syn. Cat. Orth., II, 1906, p. 193.

Eremopedes unicolor SCUDDER, Cat. Orth. U. S., App., 1900, p. 97.—CAUDELL, Can. Ent., XXXIII, 1901, p. 99; Proc. U. S. Nat. Mus., XXVI, 1903, p. 807.—KIRBY, Syn. Cat. Orth., II, 1906, p. 192.

Description.—Head as in *scudderi*. Pronotum about as in the preceding species, except that the lateral lobes are well developed and the

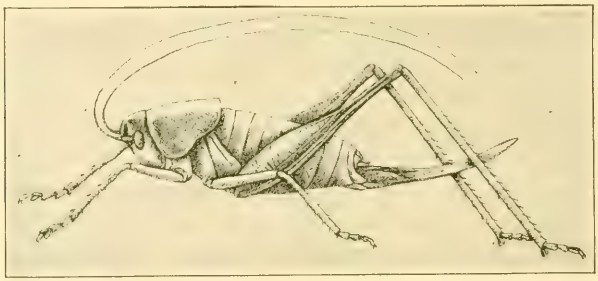


FIG. 35.—EREMOPEDES EPHIPPIATA. ADULT FEMALE.

posterior sinus distinct. Prosternum unarmed, or armed with a pair of short blunt spines rarely quite distinct and acute. Legs armed as in the type species, but the posterior femora are apparently less elongate. Abdomen moderately plump, obscurely carinate. Wings concealed in the female, in the male projecting somewhat beyond the pronotum. Ovipositor considerably shorter than the posterior femur; cerci of the female simple, pointed, of the male triangular, very stout, shaped as shown in fig. 36.

Color generally uniformly brownish, sometimes yellowish, the outer face of the posterior femur sometimes with an elongate black streak; in some specimens the lateral lobes of the pronotum are dark and the lower margins yellowish, and some specimens have the pronotal disk

yellowish, while in others it is nearly coal black. The disk of the elytra of the male is infuscated.

Measurements.—Length, pronotum, male, 6.25–7.5 mm., female, 6.5–8.5; posterior femora, male, 17–20, female, 17.5–26.5; elytra, male, 2–2.5; ovipositor, 16–19.

Type.—Cat. No. 5736, U. S. National Museum (*unicolor* Scudder).

Specimens examined.—The unique type of *unicolor* (fig. 35), a female merely labelled "Arizona," an adult female from Hot Springs, Arizona, taken by Barber on June 22; an adult male from Phoenix, Arizona (Kunze); a couple of immature females from Oracle, Arizona, in July (Schwarz); a female from Douglas, Arizona (Snow); and a female from the Huachuca Mountains, Arizona, August 18, 1903 (Oslar); and other material from Arizona and Mexico.

Fig. 36.—Eremopedes ephippiata. Cercus of male.

Professor Bruner has presented the National Museum with a large female nymph from Huachuca Mountains, Arizona (Kunze); and C. Schaeffer donated an adult pair from the same locality, taken by himself in August. The Academy of Natural Sciences of Philadelphia, has a series of 5 males and 8 females from the same locality taken by Doctor Skinner in August, 1905.

The unique male type of Scudder's *Cacopteris ephippiata* from Sonora, Mexico, has been examined. It is quite certainly conspecific with *unicolor*, which was described from the female. Thus it replaces the latter name.

This species is variable in size and color. Usually it is brownish, but sometimes is yellowish, and some have the pronotum yellow above with the sides brown, resembling somewhat the coloration of *E. scudderi* var. *bicolor*, and still others have the pronotal disk almost picious.

EREMOPEDES SCUDDERI Cockerell.

Eremopedes scudderi Cockerell, Ann. Mag. Nat. Hist. (7), II, 1898, p. 323.—Scudder, Cat. Orth. U. S., 1900, p. 78.—Caudell, Can. Ent., XXXIII, 1901, p. 101.—Kirby, Syn. Cat. Orth., II, 1906, p. 192.

Eremopedes scudderi var. *viridis* Cockerell, Ann. Mag. Nat. Hist. (7), II, 1898, p. 324.—Caudell, Can. Ent., XXXIII, 1901, p. 101.—Kirby, Syn. Cat. Orth., II, 1906, p. 192.

Eremopedes scudderi var. *bicolor* Scudder and Cockerell, Proc. Davenp. Acad. Sci., IX, 1902, p. 54.—Kirby, Syn. Cat. Orth., II, 1906, p. 192.

Eremopedes popeana Scudder and Cockerell, Proc. Davenp. Acad. Sci., IX, 1902, p. 54.—Kirby, Syn. Cat. Orth., II, 1906, p. 192.

Description.—Head moderate in size, scarcely prominent, quite deeply inserted into the pronotum; fastigium narrow, no more than one-third as broad as the interocular space, the sides concave. Eyes medium in size and rounded, moderately prominent. Antennæ slender, the basal segment as broad as the fastigium. Pronotum of

medium size, considerably produced posteriorly, the lateral lobes poorly developed, and the posterior margin very slightly sinuate; pronotal disk evenly rounded, without indication of median or lateral carinæ, truncate anteriorly, posteriorly subtruncate or very broadly rounded. Prosternum unarmed or armed with a pair of short blunt spines. Legs long and slender, the posterior femora more than three times, or about three times, as long as the pronotum, armed below in the apical half on the inner carina with a few short stout sharp spines; anterior tibiæ armed above on the outer side only with three spines. Wings lateral and wholly concealed in the female, in the male overlapping above and projecting slightly beyond the pronotum. Abdomen usually somewhat compressed and carinate above, the last dorsal segment deeply cleft in both sexes; cerci simple in the female, in the male shaped as fig. 37, projecting about half their length beyond the last abdominal segment; ovipositor long, as long or a little longer than the posterior femora.

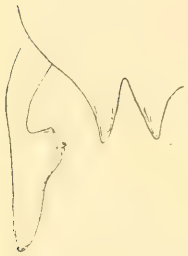


FIG. 37.—EREMOPEDES SCUDDERI. CERCUS OF MALE.

Color obscure brownish, uniformly green or brownish, with a broad ocherous band above.

Measurements.—Length, pronotum, male, 6.25–7.25 mm., female, 5.5–7.5; posterior femora, male, 20, female, 18–24; cerci, male, 3; ovipositor, 17–24.

Type.—Cat. Nos. 10173, 10174, and 10175, U. S. National Museum.

Specimens examined.—Material in various collections from Texas and New Mexico. The green form of this species has been christened var. *viridis* by Cockerell, while the varietal name *bicolor* has been applied by Scudder and Cockerell to the form with the dorsum marked with ocherous. The National Museum contains types of both these varieties as well as of the typical form; *viridis* bears the type No. 10173, while that of *bicolor* is No. 10174. The types of both varieties and the typical form are from Mesilla, New Mexico. Besides the types, the National Museum contains one male, one female, and two nymphs from the type locality, Cockerell, July and August, and one adult from El Paso, Texas (Dunn). This last was presented by Bruner. The Scudder collection has the typical form, under the name *popeana*, from Texas.

The types of *popeana* have been studied, and I entertain no doubts regarding its synonymy with the present species. Of the five specimens in the Scudder collection labeled as types of *popeana*, the specimen figured has the longest ovipositor, and none of the other four females have the ovipositor as straight as the figured specimen. No specific characters were found by direct comparison of types to satisfactorily separate *popeana* from *scudderi*, and therefore their synonymy

seems quite certain. In his original description of *popeana* Scudder states that some specimens, at least in the female and on one side, has one or two spines on the inner carina of the anterior tibia above. This statement was made by reason of an erroneous observation on the part of the describer—that of mistaking the middle leg of the right side of one of the specimens for the anterior one. These two legs were twisted across each other at the base in such a manner as to require especial care to notice the displacement.

The males of *scudderi* very much resemble those of *Idiostatus sinuata*. The types were taken in an outhouse at Mesilla Park, New Mexico, and, as stated by Cockerell, are probably nocturnal. One specimen was found killed by a centipede, *Scolopendra heros*.

EREMOPEDES BALLI Caudell.

Eremopedes balli Caudell, Can. Ent., XXXIII, 1901, p. 100 (part): Proc. U. S. Nat. Mus., XXVI, 1903, p. 807 (part).—Kirby, Syn. Cat. Orth., II, 1906, p. 192.

Description.—A much smaller species than either of the preceding ones. Pronotum with well developed lateral lobes, the posterior margin moderately sinuate, the disk more rounded in front than behind, posteriorly meeting the lateral lobes a little abruptly, there forming faint indications of lateral carinæ; median carina not indicated; anterior margin of the disk truncate, the posterior margin truncate or subtruncate. Prosternum unarmed or armed with a pair of tubercles or short blunt spines. Legs long, proportioned about as in the preceding species, the posterior femora unarmed below, the anterior tibiæ armed as in *scudderi*. Wings concealed in the female, in the male projecting somewhat beyond the pronotum. Abdomen scarcely or but slightly carinate, moderately plump. Cerci of the male as shown in fig. 38, projecting but little beyond the last abdominal segment. Ovipositor about as long as the posterior femora.

Fig. 38.—Eremopedes balli. Cercus of male.

General color brownish, lighter below. Head dark brown above, paler on the face and ventral and lateral surfaces; mandibles reddish distally with black teeth; pronotum dark above, pallid below, the lateral lobes usually margined below with pale yellow and behind on the upper portion, just below the obscurely indicated lateral carinæ, narrowly margined with black. Legs brownish, the posterior femora black at the apex and generally with one or two longitudinal black streaks on the outer face; the posterior tibiæ are black basally and the elytra of the males are blackish with yellowish margins and the veins also yellowish.

Measurements.—Length, pronotum, male 5–6 mm., female, 5–6.5; posterior femora, male, 15.5–17, female, 16–18; ovipositor, 13–17.

Type.—Cat. No. 6150, U. S. National Museum.

Specimens examined.—Six males and two females from Williams and Flagstaff, Arizona, all taken by Barber and Schwarz in July, 1901, and several adults from Baboquivaria Mountains, Arizona (Snow).

These Williams and Flagstaff specimens, the types, and the name *balli* is misleading, as the specimens taken by Mr. Ball and myself at Fort Collins, Colorado, were not this species but belongs to *Stipator stevensoni*. The specimens before me when the original description was drawn up comprised the specimens here described as well as those taken by Ball and myself and that accounts for the statement that the posterior femora are armed beneath when as a fact they are rarely if ever so armed. The omission of the Arizona habitat from the original description was due to inadvertence and is deplorable inasmuch as confusion is apt to exist owing to the unusual circumstances. This species superficially resembles *Stipator stevensoni* so closely as to make their confusion excusable. However, the cerci of the male will serve for their easy separation. Some of the largest females are very close to the smallest females of *ephippiata*, but in such cases association with the males can be relied upon for a correct determination.

This insect is probably nocturnal in habits though little is known regarding it. The types were taken under bark. If it is nocturnal in habit, living under bark, etc., in the daytime, it is in this respect very different from *Stipator stevensonii* which it so resembles in appearance. Professor Snow has taken *balli* in Arizona in the Baboquivaria Mountains in which the ovipositor is several millimeters shorter than usual, measuring but 13 mm.

EREMOPEDES BREVICAUDA, new species.

Description.—Female. Head medium in size, the vertex very broad and prominent, nearly as broad as the interocular space, broader than the width of one of the eyes; front well rounded. Eyes of moderate size, not prominent, nearly round. Pronotum of medium size and posteriorly considerably produced; lateral lobes well developed, slanting, the humeral sinus broad and shallow; lateral and median carinæ very broadly rounded, scarcely noticeable, but persistent, the former parallel; pronotal disk broadly convex and longitudinally a little bowed; anteriorly subtruncate, posteriorly rounded. The pronotal disk is without transverse culci but has an obscure crescent-shaped depression in the center. Prosternum unarmed. Elytra projecting very slightly beyond the posterior margin of the pronotum. Legs moderately stout; all the femora unarmed, the posterior ones much and quite abruptly swollen on the basal three-fifths; anterior tibiæ armed above on the outer side only with three spines; intermediate tibiæ armed above on both margins. Abdomen moderately plump and dorsally somewhat carinate. Cerci round, pointed, about three times as long as the basal width. Ovipositor (fig. 39) very short and subfalcate, not as long as the pronotum.

General color reddish yellow brown. Head with a narrow obscure brownish stripe extending along each side of the vertex to the back of the head; eyes blackish. Pronotum with the lateral lobes slightly darker than the disk, narrowly bordered along the humeral sinus with light yellowish. Abdomen slightly infuscated above and on the sides, marked longitudinally with moderately broad yellowish subdorsal stripes. Ovipositor black at the tip, the sides narrowly yellowish as is also the base. Tibiæ slightly infuscated; posterior femora longitudinally marked on the outer face with a black streak.

Measurements.—Length, pronotum, 7 mm.; posterior femora, 18; ovipositor, 6; width, pronotum across metazona, 3.5; posterior femora, across widest part, 4, across narrowest point, 1; ovipositor, across middle, 1.75.

Type.—In the collection the American Museum of Natural History, New York City.

Specimens examined.—The type, one female, Napa County, California (H. Edwards).

This is a very interesting little species and is placed in this genus

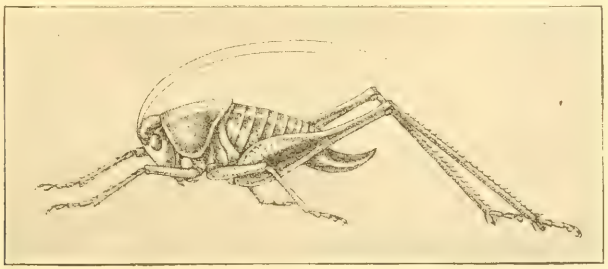


FIG. 39.—EREMOPEDES BREVICAUDA. ADULT FEMALE.

with some doubt. The persistent, but obscure, lateral carinæ of the pronotum, the broad vertex and the very short ovipositor are indicative of generic distinctness, but until the other sex is known, it is thought best to place it here. The pronotal carinæ are very obscure, but are made more apparent by reason of the pronotal disk being slightly lighter in color than that of the lateral lobes. The very short ovipositor is unique in the whole group as represented in the fauna covered by the present paper.

For the loan of this specimen for study and description I am indebted to Mr. William Beutenmuller.

EREMOPEDES ALBOFASCIATA Scudder and Cockerell.

Plagiostira albofasciata SCUDDER and COCKERELL, Proc. Davenp. Acad. Nat. Sci., IX, 1902, p. 55, pl. III, fig. 2.—KIRBY, Syn. Cat. Orth., II, 1906, p. 195.
Plagiostira gracila REHN, Publ. Kans. Acad. Sci., 1905, p. 227.

Description.—Female. Head small, not prominent, inserted deeply into the pronotum; vertex moderately broad, nearly as broad as the interocular space; front nearly straight, broadly convex. Eyes of moderate size, scarcely prominent, nearly round, slightly flattened anteriorly. Antennæ slender, more than two times as long as the body. Pronotum scarcely produced posteriorly over the basal segment of the abdomen; lateral lobes shallow, not more than one-half as deep as long, nearly vertical below, above rounded into the disk without indications of lateral carinæ at any point; humeral sinus slight, very shallow and broad; pronotal disk broadly rounded above, with a slight but distinct transverse sulcus on the anterior fifth; posterior margin broadly and shallowly concave, the anterior margin subtruncate, very slightly concave. Legs long and moderately slender; anterior coxal spines long and sharp; posterior femora moderately heavy, apically parallel for a little more than one-fourth of their length, armed below on the inner carina only with a few small stout sharp black spinules; anterior tibiæ armed above on the outer margin only with three spines. Elytra concealed beneath the pronotum, mere lateral pads, black in color with light veins. Abdomen plump, not carinate; cerci simple, conical, acute, about three times as long as the basal width; supraanal plate small, triangular, entire; last abdominal segment mesially incised apically. Ovipositor slightly curved upward, longer than the posterior femora, the tip smooth.

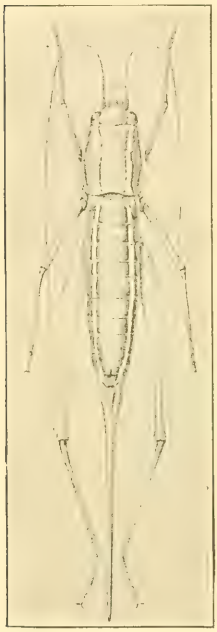


FIG. 40.—EREMOPEDES ALBOFASCIATA. ADULT FEMALE (AFTER SCUDDER).

The color is described by Scudder as follows:

Apple green, conspicuously marked with a pair of laterodorsal white stripes, edged on both sides with dull pink, running from behind the upper edge of the eyes across the prothorax and abdomen, on the prothorax converging to the anterior sulcus and thereafter subparallel (marking the position of the lateral carinæ, were they present) on the abdomen parallel, but at first diverging feebly and then converging a little more; the lower margin of the lateral lobes of the pronotum edged as broadly with white, the white margined above with pink, and this white stripe continues forward upon the head embracing the lower margin of the eye; the vertical sides of the fastigium are white basally, edged above with pink; eyes yellow with a large dark purplish patch; antennæ with the basal joints green, beyond luteous, soon passing into testaceous. Legs green, the fore and middle femora faintly infuscated. Dorsal scutes of abdomen edged posteriorly and inferiorly with white, the white margined within with pink. Ovipositor green, becoming testaceous apically.

Measurements.—Length, pronotum, 7 mm.; anterior femora, 8; posterior femora, 27; ovipositor, 29. Width, pronotum at the posterior border, 5.5.

Type. In the Museum of Comparative Zoology, Cambridge, Massachusetts.

Specimens examined.—The type specimen (fig. 40), a female taken at Mesilla Park, New Mexico by Cockerell, August 12, on *Atriplex canescens*, in the Scudder collection at Cambridge, the type of Rehn's *P. gracila* from Arizona and an apparently full-grown nymph from Phoenix, Arizona (Kunze), in the National Museum.

The above-mentioned immature specimen was presented by Bruner. It is almost exactly like the type of Rehn's *P. gracila* which was kindly loaned to me for study by Professor Snow of the University of Kansas. After examining the type of Rehn's species I unhesitatingly refer it to the synonomy under the present species. Aside from being more slender, due doubtlessly to immaturity, it presents no characters of sufficient systematic value to warrant its recognition as a distinct species.

STIPATOR Rehn.

Orchesticus Saussure, Rev. Mag. Zool., XI, 1859, p. 201 (not of Cabanis, 1851).—Scudder, Guide Orth. N. A., 1897, p. 55; Cat. Orth. U. S., 1900, p. 76.

Stipator Rehn, Trans. Amer. Ent. Soc., XXVII, 1900, p. 90; Proc. Acad. Nat. Sci., Philad., 1904 (1904), p. 543.—Kirby, Syn. Cat. Orth., II, 1906, p. 183.

Description.—Head of moderate size; vertex broad, about one-third as broad as the interocular space. Pronotum large and posteriorly moderately produced, rounded above, and without carinæ or with bare traces on the posterior portion, where the disk is sometimes slightly flattened; lateral lobes well developed; prosternum armed with a pair of spines, sometimes short, but usually long, and always distinct. Elytra of the female lateral and not, or barely, projecting beyond the pronotum, of the male overlapping above and projecting beyond the pronotum a distance equal to one-third the length of the pronotum or less. Legs moderately stout, the posterior femora more than two times as long as the pronotum and much swollen basally; anterior tibiæ armed above on the outer margin only with three spines except in *S. americanus* where both margins are sometimes armed. Supraanal plate small, rectangular in both sexes; cerci round, simple in the female, in the male armed on the inner side with a large tooth; ovipositor curved more or less upward, usually quite noticably so, and varying in length from scarcely one-fourth longer to nearly three times longer than the pronotum.

Type—Orchesticus americanus Saussure.

The variation in the armature of the anterior tibiæ is apparently confined to the type species, none others examined exhibiting this peculiarity. This is one of our largest genera, and the species is distributed quite widely over the southern and western United States and at least two species extend into Mexico. The species range in size from the largest to the smallest of our Decticinæ. As a rule they

are quite rare, though occasionally some species are not uncommon in certain localities. In food habits they are probably both herbivorous and carnivorous.

Separate tables are given for the separation of the two sexes of these insects. This was found desirable as it makes easier the determination of the species.

KEY TO THE SPECIES OF STIPATOR—MALES.

A. Cercal tooth situated much beyond the middle of the cercus, as thick, or almost as thick, and as long, or longer, than that portion of the cercus beyond it, apically rounded.
  B. Size large, pronotum 11–16 mm. in length ..... *americanus*, p. 341
  B′. Size small, pronotum 5–8 mm. in length.
    C. Posterior femora longer, armed on the inner inferior carina with several small but distinct spines; prozona nearly as convex posteriorly as anteriorly and the posterior border well rounded ..... *bruneri*, p. 343
    C′. Posterior femora relatively shorter, inconspicuously armed on the inner inferior carina with a few very minute spinules; prozona slightly flattened posteriorly and the posterior margin usually more truncate ..... *stevensonii*, p. 344
A′. Cercal tooth situated about the middle of the cercus, not as thick nor nearly as long as that portion of the cercus beyond it, apically acute.
  B. Size smaller, pronotum 8–10 mm. in length.
    C. Disk of the pronotum usually no lighter in color than the upper portions of the lateral lobes and rounded, the lateral carinæ not indicated.
      D. Antennæ usually banded. Body more robust ..... *grandis* p. 347
      D′. Antennæ uniform in color. Body more slender.
        grandis var. *insignis*, p. 349
    C′. Disk of the pronotum always lighter in color than the upper portion of the lateral lobes and slightly flattened, the lateral carinæ often indicated.
      nigromarginata, p. 346
  B′. Size large, pronotum 11–13 mm. in length ..... *grandis*, p. 347

KEY TO THE SPECIES OF STIPATOR—FEMALES.

A. Large, pronotum 11–16 mm. in length.
  B. General color yellow; pronotum usually a little flattened posteriorly and there with a trace of a median carina on each side of which is usually a broad fuscous patch, strongly contrasted with the general color; ovipositor rarely as little as 25 mm. in length ..... *americanus*, p. 341
  B′. General color brown or yellowish-brown; pronotum not flattened posteriorly and without a trace of median carina or fuscous patches; ovipositor rarely over 25 mm. in length ..... *grandis*, p. 347
A′. Smaller, pronotum 5–10 mm. in length.
  B. Dorsal surface of the pronotum and the upper half of the lateral lobes usually unicolorous; size variable.
    C. Posterior femora inconspicuously spined on the inner-inferior carina with a few very minute spinules ..... *stevensonii*, p. 344
    C′. Posterior femora more conspicuously spined on the inner-inferior carina with several small spines.
      D. Larger, pronotum 9–10 mm. in length; posterior femora scarcely infuscated apically.
        E. Stouter; antennæ usually banded ..... *grandis*, p. 347
        E′. More slender; antennæ uniform in color ..... *grandis* var. *insignis*, p. 349

D′. Smaller, pronotum 7–8 mm. in length; posterior femora deeply infuscated apically ..... *bruneri*, p. 343

B′. Pronotum dorsally light yellowish, always lighter colored than the upper half of the lateral lobes, which are infuscated; size medium, pronotum about 8 or 9 mm., rarely 10 mm. in length.

C. Posterior femora slender, more than five times as long as the basal width; lateral lobes well developed, fig. 44 ..... *nigromarginata*, p. 346

C′. Posterior femora stout, less than five times as long as the basal width; lateral lobes less developed ..... *ateloploides*, p. 350

STIPATOR AMERICANUS Saussure.

Orchesticus americanus Saussure, Rev. Mag. Zool., XI, 1859, p. 201; Orth. Nova. Amer., I, 1859, p. 5.—Walker, Cat. Derm. Salt. Orth. Brit. Mus., II, 1869, p. 248.—Scudder, Can. Ent., XXVI, 1894, pp. 180, 183; Cat. Orth. U. S., 1900, p. 76.

Stipator americanus Rehn, Trans. Amer. Ent. Soc., XXVII, 1900, p. 90.—Kirby, Syn. Cat. Orth., II, 1906, p. 183.

Anabrus haldemanii Girard, Marcy's Expl. Red River, 1853, p. 259, pl. xv, figs. 5–8; 1854, p. 248, pl. xv, figs. 5–8.—Walker, Cat. Derm. Salt. Orth. Brit. Mus., II, 1869, p. 239.—Thomas, Ann. Rept. U. S. Geol. Surv. Terr., II, 1871, p. 265; Can. Ent., XII, 1880, p. 223; Rep. U. S. Ent. Comm., II, 1881, p. 259.—Glover, Ill. N. A. Ent., Orth., 1872, pl. vii, fig. 16.

Pterolepis haldemanii Thomas, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 441.

Thyreonotus haldemanii Bruner, Publ. Nebr. Acad. Sci., III, 1893, p. 31.

Stipator haldemanii Rehn, Trans. Amer. Ent. Soc., XXVII, 1900, p. 90.—Kirby, Syn. Cat. Orth., II, 1906, p. 183.

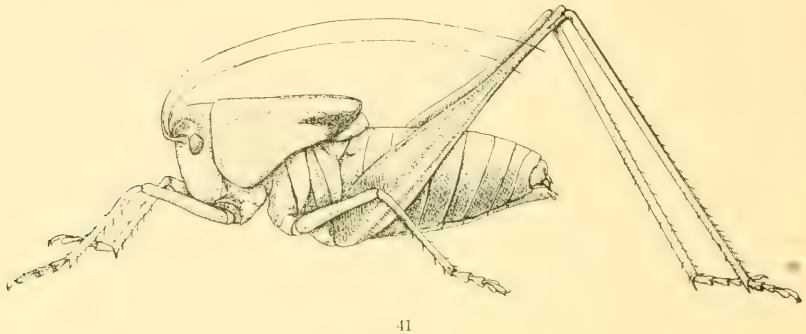
Thyreonotus cragini Bruner, Bull. Washb. Coll., I, 1885, p. 129; 1886, p. 196; Publ. Nebr. Acad. Sci., III, 1893, p. 31.

Orchesticus cragini Scudder, Can. Ent., XXVI, 1894, pp. 180, 183; Cat. Orth., U. S., 1900, p. 76.

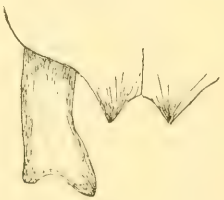
Stipator cragini Rehn, Trans. Amer. Ent. Soc., XXVII, 1900, p. 90.—Kirby, Syn. Cat. Orth., II, 1906, p. 183.

Description.—Head moderately prominent, no broader than the front of the pronotum, into which it is quite deeply set; fastigium one-third as broad as the interocular space, scarcely two times as broad as one of the eyes; front but little convex; eyes medium in size, moderately prominent, nearly round; antennæ long and slender, much longer than the body. Pronotum large and posteriorly much produced over the base of the abdomen; lateral lobes well developed, but not nearly as deep as long, nearly vertical, the posterior margin strongly sinuous; lateral and median carinæ wholly absent on the anterior portion of the pronotum, on the posterior portion indicated more or less plainly behind a transverse sulcus that crosses the disk somewhat behind the middle; pronotal disk rounded on the anterior portion, behind the transverse sulcus, usually somewhat flattened, the anterior margin truncate, posterior margin semicircularly rounded; prosternal spines moderately long and slender. Wings lateral and wholly concealed beneath the pronotum in the female, in the male much overlapping above and projecting somewhat beyond the pronotum. Legs long and stout; anterior tibiæ armed above on the outer

margin with three spines and on the inner margin with one or two spines or unarmed; posterior femora more than two times as long as the pronotum and much swollen on the basal two-thirds, usually armed on the apical half beneath, on the inner carina with a number of small sharp spinules, but sometimes very minute or wholly absent. Abdomen large and plump, scarcely carinate above; cerci of the male about four times as long as the basal breadth, bent inward on the apical third and on the curved outer margin with a blunt tooth not as long as the circal width at that point (fig. 42), of the female simple, tapering to a sharp point, about three or three and one-half times as long as the basal width; ovipositor varying from one-sixth shorter to slightly longer than the posterior femora, nearly straight in the basal two-thirds, apically very moderately curved upward.



41



42

FIGS. 41, 42.—STIPATOR AMERICANUS. 41, ADULT MALE. 42, CERCUS OF MALE.

General color yellow, the tip of the ovipositor usually infuscated, the elytra of the males blackish, with yellow outer and apical margins; the disk of the pronotum (fig. 41) has the posterior margin black and behind the transverse sulcus marked on either side of the median carina with a broad black band, usually very conspicuous, seldom obscure, and very rarely indistinct or missing. The general color is sometimes much darker than usual, but usually it is distinctly yellow.

Measurements.—Length, pronotum, male, 11–14 mm., female, 11–16; posterior femora, male, 24–32; female, 26–39; ovipositor, 25–32; cerci of male, 3.

Specimens examined.—A large number of specimens of both sexes, both adult and immature, from various regions in the middle and southern United States.

Americanus occurs throughout the middle and southern United States from Wyoming and Texas and east to Tennessee. The adults appear as early as May in Texas, and specimens in the National Museum from Kansas and Colorado are labeled as having been taken in September. The present species is peculiar in having the anterior tibiæ armed above sometimes on one margin only and sometimes on both margins. Such variability is unknown in any other member of the genus. Little difficulty will be found in the identification of this large insect. The size alone at once separates it from all other species except *grandis* and the color, markings, length of the ovipositor and the structure of the cerci of the male serve to easily separate it from that species.

The insect here described is very surely the *americanus* of Saussure. In his description of the genus *Orchesticus* he describes the pronotum as subcarinate, and this is the only species of the genus known to me of which this is true, nor has any other of our species of *Stipator* got ovipositors long enough to fit the measurements given by Saussure for *americanus*. The synonomy of *haldemanii* and *cragini* with this species has been arrived at by a careful study of descriptions and illustrations, as well as an examination of types of *cragini* and specimens of *haldemanii* in the U. S. National Museum.

In spite of the somewhat extended bibliography of *americanus* there is nothing published, so far as known to me, bearing upon the life history or habits.

STIPATOR BRUNERI, new species.

Description.—Head of moderate size, not prominent, quite deeply inserted into the pronotum; fastigium prominent, one-third as broad as the interocular space; front as in *americanus*. Eyes rounded, moderately prominent; antennæ very long and slender. Pronotum large and much produced posteriorly; lateral lobes well developed, slightly slanting outward and quite strongly sinuous behind; lateral and median carinæ not indicated at any point, the pronotal disk smooth and evenly rounded, without transverse sulce or with a very inconspicuous one; anterior margin of the pronotal disk truncate, the posterior margin semicircularly rounded; prosternal spines distinct, usually short and somewhat blunt. Wings completely concealed beneath the pronotum in the female, in the male overlapping dorsally and projecting very little beyond the pronotum; anterior tibiæ armed above on the outer margin only with three spines; posterior femora long and shaped as in *americanus*, armed below on the inner carina with several distinct but small spines. Abdomen moderately stout, scarcely carinate; cerci of the male scarcely more than three times as long as the basal width and apically forked, the outer branch blunt and nearly in a line with the main body of the cercus and the inner branch at a right angle with it and sharp pointed, a little decurved,

very similar to the figure of the cerci of the next species (fig. 43). The cerci of the female are simple, pointed, about three times as long as the basal width. Ovipositor short and heavy, usually but little more than one-half as long as the posterior femora, but sometimes three-fourths as long and curved upward.

General color brownish, sometimes yellowish brown; tip of the ovipositor, knees of the posterior femora and edge of the posterior margin of the pronotum blackish and the lower and posterior margins of the pronotum usually, but not always, yellowish, much lighter than the general color.

Measurements.—Length, pronotum, male, 7–8 mm., female, 7.5–8; posterior femora, male, 21–24, female, 24–25; cerci, male, about 1.5; ovipositor, 13–18.

Type—Cat. No. 10169, U. S. National Museum.

Material examined.—Five males, five females, Texas, Types, U. S. National Museum, and specimens from the same State in the collections of Scudder and Morse.

Described from two males and five females from Texas (Belfrage).

The Scudder collection contains one pair from the same collection, and Professor Morse took a female at Quanah, Texas, on August 21. This specimen has the ovipositor, 18 mm. long, 4 mm. more than the other females studied. Otherwise it is normal.

The longer posterior femora with the more distinct ventral spines and the usually shorter ovipositor will serve to separate this species with considerable certainty from its nearer allies.

STIPATOR STEVENSONII Thomas.

Anabrus stevensonii Thomas, Proc. Acad. Nat. Sci. Phila., 1870, p. 75; Ann. Rept. U. S. Geol. Surv. Terr., II, 1871, pp. 265, 266.—Glover, Ill. N. A. Ent., Orth., 1874, pl. xviii, fig. 19.

Pterolepis stevensonii Thomas, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 441.

Orchesticus stevensonii Scudder, Can. Ent., XXVI, 1894, pp. 180, 183; Cat. Orth. U. S., 1900, p. 77.

Stipator stevensonii Rehn, Trans. Amer. Ent. Soc., XXVII, 1900, p. 90.—Kirby, Syn. Cat. Orth., II, 1906, p. 183.

Anabrus minutus Thomas, Proc. Acad. Nat. Sci., Phila., 1870, p. 75; Ann. Rept. U. S. Geol. Surv. Terr., II, 1871, pp. 265, 267.—Bruner, Publ. Nebr. Acad. Sci., III, 1893, p. 31.

Pterolepis minutus Thomas, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 441.—Glover, Ill. N. A. Ent., Orth., 1872, pl. xi, fig. 17.

Orchesticus minutus Scudder, Can. Ent., XXVI, 1894, pp. 180, 183; Cat. Orth. U. S., 1900, pp. 76, 77.

Stipator minutus Rehn, Trans. Amer. Ent. Soc., XXVII, 1900, p. 90.—Kirby, Syn. Cat. Orth., II, 1906, p. 183.

Thyreonotus scudderi Bruner, Bull. Washb. Coll., I, 1885, pp. 129, 130; 1886, p. 196; Publ. Nebr. Acad. Sci., III, 1893, p. 31.

Orchesticus scudderi Scudder, Can. Ent., XXVI, 1894, pp. 180, 183; Cat. Orth., U. S., 1900, p. 77.

Stipator scudderi Rehn, Trans. Amer. Ent. Soc., XXVII, 1900, p. 90.—Kirby, Syn. Cat. Orth., II, 1906, p. 183.

Description.—Head, pronotum, abdomen, and wings as in the preceding species except that the posterior margin of the pronotal disk is less rounded than in *bruneri*, being sometimes almost truncate. Prosternal spines variable, sometimes short and blunt and sometimes quite long and sharp. Anterior tibiæ armed above on the outer margin only with three spines, very rarely with four; posterior femora somewhat more abruptly swollen basally than in *bruneri*, and the inner carina below is unarmed or armed with but a few very inconspicuous spinules, rarely at all prominent; cerci shaped as in *bruneri*, those of the male relatively longer, as compared with the basal width (fig. 43). Ovipositor more slender than in *bruneri* and generally considerably longer, being from about two-thirds as long to fully as long as the posterior femora.

Color as described under the preceding species and similarly variable.

Measurements.—Length, pronotum, male, 5–6.5 mm., female, 5–7; posterior femora, male, 16–18, female, 15–21; cerci of male, about 1.5; ovipositor, 14–18.

Type.—Cat. No. 1106, U. S. National Museum.

Specimens examined.—Many specimens in various collections from localities from South Dakota through Nebraska, Kansas, and Colorado to New Mexico. A male in the collection of the National Museum is labeled "Florida," but very probably erroneously so.

Superficially this species resembles very closely a species of the genus *Eremopedes*.[a] I have taken it on a stony hillside in Colorado, at the base of the mountains, actively hopping about during the middle of the day. They are adepts at eluding capture, their color harmonizing well with that of the surrounding grass and stones.

The synonymy of *minutus* and *stevensonii* seems very certain. The type of *stevensoni* seems to be lost, but the figure given by Glover shows no specific differences between that species and *minutus*. Glover's figure was made soon after the description of *stevensoni*, and as he always, when possible, drew from authentic specimens, conclusions may usually be based upon his drawings with considerable certainty. His figure agrees in size with those given by Thomas, and the original description fails to give any sufficient character for separating it from *minutus*. A careful examination of the original descriptions of both *stevensoni* and *minutus*, examination of the figures of both species by Glover and a study of the types of *minutus* and a series of additional specimens of that species leads me to the conclusion that there is but one species represented. The type of Bruner's *scudderi* has been seen and found to belong here.

FIG. 43.—STIPATOR STEVENSONII. CERCUS AND LAST ABDOMINAL SEGMENT OF MALE.

[a] See discussion under *Eremopedes balli* on p. 336.

STIPATOR NIGROMARGINATA Caudell.

Orchesticus nigromarginata CAUDELL, Trans. Amer. Ent. Soc., XXVIII, 1902, p. 89.
Stipator nigromarginatus KIRBY, Syn. Cat. Orth., II, 1906, p. 183.

Description.—Vertex moderately broad, about one-half as broad as the interocular space; eyes rounded, anteriorly truncate, scarcely prominent. Pronotum well produced prosteriorly; lateral lobes longer than deep, the posterior margin sinuate; disk very slightly flattened; lateral carinæ very slightly indicated but more noticeably located by the abrupt change in color from the usually light colored dorsum to the infuscated upper portion of the lateral lobes; median carina not indicated. Legs, wings, abdomen, cerci, and ovipositor as in *grandis* var. *insignis*. Color varying shades of brown with the upper part of the lateral lobes of the pronotum and sides of the abdomen nearly always black, conspicuously contrasted with the top of the pronotum and abdomen which are much lighter in color. This lateral infuscation of the pronotum and abdomen extends also onto the head, embracing the eyes and

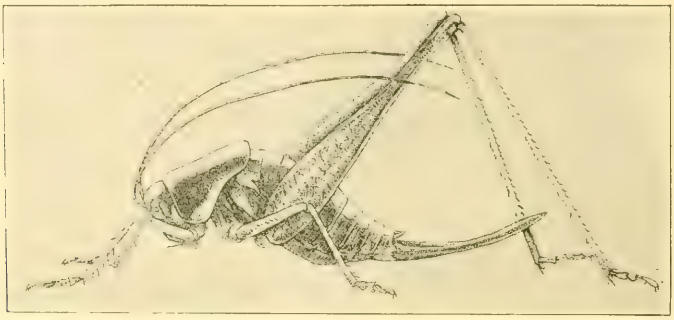


FIG. 44.—STIPATOR NIGROMARGINATUS. ADULT FEMALE.

sides of the fastigium. The antennæ are uniformly brown or, rarely, light banded. The lateral infuscation of the sides is sometimes more or less broken and the disk of the pronotum is sometimes, but rarely, dark, not so distinctly contrasted with the sides.

Measurements.—Length, pronotum, male, 7.5–8.5 mm., female, 8–10; posterior femora, male, 22.5–23, female, 26–29; ovipositor, 16–21.5; width, posterior femora at the base, male, 3.75, female, 4.5.

Type.—Cat No. 6119, U. S. National Museum.

Specimens examined.—The type, a single female, from Texas (Belfrage), and a female (fig. 44) from Perkins, Oklahoma, August 13, and material from Kansas and Texas.

In June and August, 1904, Prof. F. B. Isely, of Wichita, Kansas, sent me some nymphs from Clearwater, Kansas, and Barber took nymphs at Brownsville, Texas, in May. In the Scudder collection are two males and one female from Lakin, Kansas, 3,000 feet, September 1, and one female from Texas and one from Georgia.

In the central United States the young of *nigromarginata* probably issue in May and mature in July. Professor Isely writes me that the nymphs make no attempt to escape capture by leaping, but only by running. This seems almost incredible in view of the well-developed posterior femora, which are certainly better fitted for leaping than for running.

STIPATOR NIGROMARGINATUS var. GRISEIS, new variety.

Description.—Differing quite distinctly from the typical form in being light gray in color. The dorsum is somewhat lighter than the upper part of the lateral lobes, as in typical specimens. It is a good color form and is worthy of a varietal name.

Measurements.—Length, pronotum, male, 7.5 mm., female, 8.5; posterior femora, male, 21, female, 26; ovipositor, 20; width, posterior femora at the base, male, 3.75, female, 4.5.

Type.—Cat. No. 10171, U. S. National Museum.

Specimens examined.—One male, one female, Haigler, Nebraska (Carriker), and other specimens in the Bruner collection.

STIPATOR GRANDIS Rehn.

Stipator grandis Rehn, Proc. Acad. Nat. Sci. Phila., 1904, pp. 544, 545.—Kirby, Syn. Cat. Orth., II, 1906, p. 183.

Description.—Head quite large and prominent; fastigium prominent, about as broad as the length of one of the rounded and moderately prominent eyes; antennæ long and slender. Pronotum large, extending well back over the base of the abdomen; lateral lobes longer than high and moderately slanting, the posterior margin moderately sinuate; carinæ not indicated, neither lateral nor median, the disk uniformly rounded, usually slightly broader posteriorly; posterior margin semicircularly rounded, anterior margin truncate. Prosternal spines long and sharp. Wings wholly concealed beneath the pronotum in the female, in the male projecting slightly, as in *americanus*. Anterior tibiæ armed above on the outer margin only with three spines; posterior femora more than two times as long as the pronotum and much swollen on the basal three-fifths, armed beneath on the inner carina with several short, sharp black spines; anterior femora armed below on the inner carina with a few short stout black spines, the middle femora sometimes with one or two similar ones. Abdomen moderately heavy, usually more slender than that of *americanus* and scarcely carinate. Cerci of the male about four times as long as the basal width, and furnished on the inner side near the middle with a heavy sharp tooth as long as the cercal width at that point, like that of var. *insignis* (fig. 45). Cerci of the female simple, acute, and about the same relative length as those of the male. Ovipositor variable in

length, varying from about one-half as long to nearly as long as the posterior femora, moderately curved upward.

Color varying from dark to light brown, the antennæ ringed with brown; lateral lobes of the pronotum with the lower borders generally noticeably lighter in color than the rest; sometimes the disk of the pronotum is much lighter than the upper part of the lateral lobe, while in other cases the color is quite uniform. One specimen, a male from Texas, has yellow stripes marking the sites of the lateral carinæ of the pronotum and another, from Brownsville, Texas, has the disk green. Tibial spines usually black at the base and the short spines on the femora black.

Measurments.—Length, pronotum, male, 9–13 mm., female, 10.5–13; posterior femora, male, 26–35, female, 32–37; cercus, male, about 3, ovipositor, 15–29.

Type.—In the Academy of Natural Sciences, Philadelphia.

Specimens examined.—The type and other specimens from Mexico and a number of individuals from Texas.

The type, a single female, is from Alta Mira, Tamaulipas, Mexico, taken on June 27, by M. E. Hoag. The National Museum contains two pairs—a female from Carrizo Springs, Texas, August 28, collected by Dr. A. Wadgymar in 1885, a male from Brownsville, Texas, taken by C. H. T. Townsend, and one pair taken at Brownsville, Texas, by C. Schæffer.

Besides these I have seen specimens in the Scudder collection from Eagle Pass, Texas, Montelovey, Mexico, and from Texas without definite locality; also a number of both sexes from Texas, in the collection of the Museum of Comparative Zoology in Cambridge, Massachusetts, and Bruner has specimens from Carrizo Springs, Texas. Others are in the Museum of the Brooklyn Institute of Arts and Sciences, in Brooklyn, New York. Professor Morse has taken what he says is this species in Oklahoma. Two pairs from Brownsville, Texas, taken by Schæffer are much below the average in size, but seem to present no structural differences. The size as represented by these four specimens, one male and one female of which is in the National Museum, a gift from the collector, are as follows:

Length, pronotum, male, 9 mm., female, 10.5; posterior femora, male, 26–28, female, 33; ovipositor, 15–18.

This species attains the largest size of any other member of the genus except *S. americanus*. From *americanus* it is usually separable with but little difficulty by the characters given in the table of species. The color is quite variable, but the most striking variation is in the length of the ovipositor. A complete gradation from the shorter to the longer ovipositor exists, the following lengths represented by the series examined: 15, 18, 19, 20, 21, 22, 23, 25, 29. The cerci of young males have the inner tooth much shortened.

STIPATOR GRANDIS var. INSIGNIS, new variety.

Description.—Head medium in size, not prominent; fastigium broad, one-half or more as broad as the interocular space, very prominent. Eyes medium, not prominent, well rounded. Pronotum very narrow and slender, posteriorly much produced; lateral lobes well developed but not as deep as long, the posterior margin strongly sinuous; carinæ none; pronotal disk evenly rounded, anteriorly truncate, posteriorly semicircularly rounded, no transverse sulci noticeable. Prosternal spines well developed. Legs long, the posterior femora much but gradually swollen on the basal three-fifths, armed below on the inner carina with several short stout sharp spines, directed backwards; anterior tibiæ armed above on the outer margin only with three long spines. Wings concealed in the female, in the male the elytra overlap above and project slightly beyond the pronotum. Abdomen long and narrow, scarcely carinate above; cerci in the male round and armed on the inner side about the middle with a large sharp tooth as long as the cereal width at that point (fig. 45), in the female simple, pointed; ovipositor about two-thirds as long as the posterior femora, moderately stout and curved upwards in the apical third.

Color brown, usually darker at the tips of the posterior femora and ovipositor; disk of the pronotum and the upper portions of the lateral lobes usually unicolorous, disk of the elytra of the male black with yellowish borders; lateral lobes of the pronotum margined below with yellowish; antennæ uniformly light brown in all specimens examined.

FIG. 45.—STIPATOR GRANDIS VAR. INSIGNIS. CERCUS OF MALE.

Measurements.—Length, pronotum, male, 9–9.5 mm., female, 9–10; posterior femora, male, 25–28, female, 27–31; ovipositor, 16–20.

Type.—Cat. No. 10170, U. S. National Museum.

Specimens examined.—One male and three females, the types, from Dallas, Texas, three males and five females in the Scudder collection, all from the type locality, and one male from San Antonio, Texas, June, in Professor Bruner's collection; also one male from Kansas, one immature specimen from Brownsville, Texas (Barber), and one adult female from the same locality (Snow), in the National Museum collection.

Occasionally this variety has the sides of the pronotum black, as in *nigromarginata*, to which species this is quite closely related in many ways. But this insect is surely distinct from *nigromarginata*, though the differences are more easily seen than described. The more broadly rounded pronotum of *nigromarginata*, together with the more often blackened lateral lobes of the pronotum, will usually serve to separate it from this insect.

STIPATOR ATELOPLOIDES, new species.

Description.—Female, head moderately large and well inserted into the pronotum; vertex prominent and narrow, scarcely one-half as broad as one of the eyes; interocular space as broad as one of the eyes; eyes moderate in size and prominence, slightly longer than broad. Pronotum large and posteriorly well produced, but the lateral lobes are poorly developed, being so shallow as to give the insect a distinct resemblance to members of the genus *Ateloplus*. The posterior margins of the lateral lobes are scarcely sinuous and the lateral and median carinæ are not indicated. Pronotal disk regularly rounded, subtruncate both anteriorly and posteriorly, not much broader behind than in front, marked across the middle of the anterior half by a slight transverse sulcus. Prosternum armed with a pair of short erect spines. Legs stout; posterior femora much swollen on the basal two-thirds, armed below on each margin with a few short, stout, black spines; anterior tibiæ armed above on the outer side with three spines; middle tibiæ armed above on both margins; anterior and intermediate femora armed below on one side only with two or three short, stout spinules. Elytra and wings wholly aborted. Abdomen plump, obscurely carinate above; cerci short and stout, about two and one-half times as long as the basal width and tapering to a point. Ovipositor two-thirds as long as the posterior femora and curved moderately upward. General color pale yellowish with the spinules of the femora black, those of the tibiæ black at the base and at the tip; abdomen sprinkled with nearly microscopic round, black spots, the posterior margin of each segment with a row of the largest ones, and marked on the side at the base with an elongate fuscous patch which extends back to about the middle of the abdomen. This fuscous patch is the continuation of a lateral thoracic band which bends upward on the middle of the pronotum, leaving the lower margin of the lateral lobes yellow and giving the pronotal disk a clepsydrate appearance. The anterior and intermediate femora and tibiæ are splotched with fuscous, the former apically, the latter basally.

Measurements.—Length, pronotum, 7 mm.; posterior femora, 20; ovipositor, 13; width, posterior femora at widest point, 4.5, at narrowest point, 1.5.

Type.—Cat. No. 10172, U. S. National Museum.

Specimens examined.—One female, the type, San Jose del Cabo, Mexico. Presented by Professor Bruner.

This species is in general appearance an aberrent member of the genus, though in general structure it is unmistakably a *Stipator*. The less slender posterior femora, and especially the shallow lateral lobes of the pronotum, give it much the appearance of an *Ateloplus*, but the armed prosternum prohibits its reference to that genus.

ANABRUS Haldeman.

Anabrus HALDEMAN, Stansb. Expl. Utah, 1852, p. 371.—HERMAN, Verhandl. der k. k. zool.-bot. Gesellsch. Wien, XXIV, 1874, pp. 200, 209.—THOMAS, 2d Rept. U. S. Ent. Comm., 1880, p. 169.—KIRBY, Syn. Cat. Orth., II, 1906, p. 191.

Description.—Head moderately large and prominent, quite deeply inserted into the pronotum; eyes rounded and moderately prominent; vertex quite prominent, about one-third as broad as the interocular space. Pronotum large and much produced posteriorly; lateral carinæ not indicated on the anterior half, posteriorly present but blunt or obscure; median carina present on the posterior portion only and there very obscure, sometimes scarcely discernible; disk smooth, evenly rounded transversely on the anterior half, posteriorly somewhat flattened, a slight transverse sulcus across the anterior portion, usually scarcely noticeable and never conspicuous, and marked near the middle with a V-shaped sulcus or depression, usually quite noticeable; anterior margin of the disk truncate, the posterior margin subtruncate or broadly rounded; lateral lobes well developed, posteriorly sinuate. Prosternum unarmed. Wings of female broad, nearly but not quite meeting on the dorsal line but wholly concealed beneath the pronotum; of male overlapping, strongly convex and projecting slightly beyond the pronotal disk. Legs short and stout, the posterior femora less than two times as long as the pronotum, except in *A. longipes*, and armed below on both margins with from one to several small spines; anterior tibiæ variable in armature, the outer side armed with from three to five, usually four or five, spines and the inner side unarmed or, usually, armed with from one to three spines, the usual number being one or two. Abdomen plump, not carinate. Cerci simple and conical in the female, in the male apically flattened and furcate, the branches forming two sharp incurved claws; subgenital plate apically broadly notched in both sexes, in the female with acute angles and at the base on each side with an apically rounded lobe which may be designated as the subgenital lobes; supraanal plate triangular, usually almost hidden, especially in the male; ovipositor varying in length from a little shorter to considerably longer than the posterior femora and curved slightly and quite uniformly upward, rarely straight.

Type.—*Anabrus simplex* Haldeman.

The members of this genus and the one following comprise the only injurious members of our Decticinæ. Hordes of *Anabrus* at times invade cultivated areas in the western United States and do immense damage. They are known by several common names, among which are great plains cricket, western cricket, war cricket, army cricket, mormon cricket, Idaho cricket, coulee cricket, and Idaho devil. This

latter name, however, is more often applied to members of the stenopelmatid genus *Stenopelmatus*.

There has been recognized three distinct species of *Anabrus*, ranging from the plains east of the Rocky Mountains to the Pacific, and some orthopterists believe there are really many more species. In my study of the genus I have examined several hundred specimens from localities ranging from Kansas to California, north to Washington and British Columbia, and from altitudes varying from the plains of Kansas to the treeless heights of mountain peaks. Much time has been spent in search for stable characters for the separation of the various described species. So great is the range of variation in both structure and coloration and so apparently distinct are the extremes that the multiplicity of forms seemed at first certain, but such seems now scarcely probable of proof. With but a few specimens from different localities before him a worker will find the recognition of two or more forms easy, but the examination of a long series usually merges the supposedly distinct species into one. In 1897 Scudder[a] separates the species apparently to his satisfaction. There he considers the form occurring in Washington and recorded as *purpurascens* to be not that species, but *simplex*. But two years later, in his Catalogue of the Orthoptera of the United States, he includes Washington in the habitat of *purpurascens*, thus showing a reversal of opinion. An examination of the Scudder collection shows no satisfactory division of this genus into species, a fact expressive of the difficulty of the task. In the course of my investigation and studies I found some promising characters, but upon trial their value as stable means of separating the mass of material into species proved unreliable.

Professor Gillette suggested, and for a time strenuously maintained, that the relative lengths of the posterior and intermediate tibiæ were of specific value for the separation of *simplex* and *purpurascens*, in *simplex* the posterior tibiæ being less than two times as long as the intermediate ones, while in *purpurascens* the hind tibiæ are twice or more than twice as long as the middle ones. But when determined by this character both *simplex* and *purpurascens* were found in nearly every State and Territory where either species is known to occur, and material, obviously of one catch, yielded both species. The subgenital lobes of the females also presented promising possibilities, but upon trial were also found wanting. Their extending to or beyond the apex of the subgenital plate seemed very suggestive of a differentiating character, but the examination of a large number of specimens resulted in the rejection of this as a specific character. Color is also useless, as individuals of all shades are said to be found among living swarms. Putnam says that scarcely any two of the many specimens seen in Middle Park, Colorado, were colored alike. Length and shape of ovipos-

[a] Psyche, VIII, p. 95.

itor were considered as were also size and habitat, but none proved serviceable for the separation of the specimens before me into species.

That *Anabrus coloradus* is but a form of *A. simplex* is strongly indicated by the fact that the author himself probably failed to properly differentiate his own species since he mentions specimens occurring in high altitudes in Colorado as *purpurascens*, while *coloradus* is certainly the typically alpine form, and Scudder has pointed out that the high altitude species mentioned by Thomas was not *purpurascens*, but *coloradus*. Again, specimens which are very probably *coloradus*, from Middle Park, Colorado, were treated of by Putnam and Thomas as *A. simplex*. This all goes to show that the separation of these species was not satisfactory, and my reduction of them to varieties of one species seems to me amply justified.

My studies have been confined almost entirely to cabinet specimens, and future examination of living or fresh material may justify the restoration of the varietal names here employed to specific rank and the recognition of additional species. But for the present I am unable to consider our described forms as representing more than one species, recognizing, however, a number of named varieties. The habits of all being essentially the same I consider indicative of their being conspecific. This complex species and two new ones herein characterized may be separated by the following table:

KEY TO THE SPECIES OF ANABRUS.

A. Posterior femora less than two times as long as the pronotum.
  B. Cerci of the male with the apical branches not widely divergent (fig. 47). Smaller, pronotum of both sexes under 15 mm. in length.....*simplex*, p. 353
  B′. Cerci of the male with the apical branches widely divergent (fig. 48). Larger, pronotum of both sexes more than 15 mm. in length.....*cerciata*, p. 361
A′. Posterior femora more than two times as long as the pronotum...*longipes*, p. 361

ANABRUS SIMPLEX Haldeman.

Anabrus simplex Haldeman, Stansb. Expl. Utah, 1852, p. 372, pl. x, fig. 4.—Aldrich, Bull. no. 41, Exp. Stat., Idaho, 1904, p. 302, fig.—Doten, Bull. no. 56, Exp. Stat., Nevada, 1904, p. 10. pl.—Gillette, Ent. News, XV, 1904, p. 321, pl. xix.—Gillette and Johnson, Bull. no. 101, Exp. Stat., Colorado, 1905, pp. 1–16, pl. i.—Rehn, Ent. News, XVII, 1906, p. 288.—Kirby, Syn. Cat. Orth., II, 1906, p. 191. [Additional references in Scudder's Index of Orthoptera (1901).]

Anabrus purpurascens Uhler, Proc. Ent. Soc. Philad., II, 1864, p. 550.—Hollis, Bull. no. 38, U. S. Dept. Agric., Bur. Ent., 1904, p. 107.—Kirby, Syn. Cat. Orth., II, 1906, p. 191. [Additional references in Scudder's Index of Orthoptera (1901).]

Acheta nigra Lord, Nat. in Vanc., I, 1866, pp. 264–6.

Thamnotrizon purpurascens Thomas, Proc. Acad. Nat. Sci. Philad., 1870, p. 76; Ann. Rept. U. S. Geol. Surv. Terr., II, 1871, pp. 265, 268.

Anabrus similis Scudder, Rept. U. S. Geol. Surv. Nebr., 1872, p. 249; Can. Ent. XXVI, 1894, pp. 181, 183.—Kirby, Syn. Cat. Orth., II, 1906, p. 191.

Anabrus coloradus THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 440.—KIRBY, Syn. Cat. Orth., II, 1906, p. 191. [Bibliography in Scudder's Index of Orthoptera (1901).]

Anabrus sp. SCUDDER, Psyche, VIII, 1897, p. 95.

Description.—Head as described under the genus, the front moderately full and broadly rounded; antennæ long and slender, the basal segment broad, about one-half as large as one of the eyes. Pronotum with the lateral carinæ on the posterior portion moderately sharp and distinct to very rounded and obscure, the median carina often almost absent, sometimes quite distinct but always low; sulci of the disk as described under the genus, variable in distinctness; posterior margin of the disk varying in contour, often subtruncate but sometimes quite rounded. Legs short, the posterior femora never quite twice as long as the pronotum; anterior tibiæ armed above on the outer side with from three to five spines, usually four or five, and on the inner side with one or two, sometimes with as many as three and sometimes unarmed. Cerci of the male as shown at fig. 47; the branches are nearly parallel,

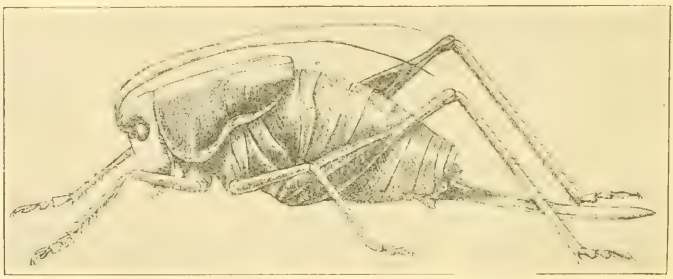


FIG. 46.—ANABRUS SIMPLEX. ADULT FEMALE.

the interspace being U-shaped, both branches curved strongly inwards, the lower being acute and considerably the longer, the upper sometimes blunt, scarcely pointed. Subgenital lobes of the female varying in length, sometimes extending just to the end of the subgenital plate and again reaching distinctly beyond it. Ovipositor varying from shorter to considerably longer than the posterior femora and in shape from nearly straight (fig. 46) to moderately curved upwards, usually distinctly curved.

Color varying from light yellow to shiny black, often, especially in life, grass green. The body is sometimes uniform in color and sometimes evenly mottled or varyingly marked.

Measurements.—Length, pronotum, male, 7–14.5 mm., female 9–15; posterior femora, male, 12–23, female, 14–26; posterior tibia, male, 11–22, female, 13–26; intermediate tibia, male, 5–13, female, 6.5–14; ovipositor, 15–28.

Specimens examined.—Numerous specimens from almost the whole of the United States west of the States bordering the Mississippi river.

Four forms of this species are here recognized and named. *Coloradus* is probably worthy of varietal distinction, but the others are given names only as a matter of convenience, not being considered as of more than mere color-variational distinctness. These forms may be separated by the following key.

KEY TO THE VARIETIES OF ANABRUS SIMPLEX.

A. Larger pronotum generally more than 11 mm. in length.
  B. Color variable but not shining black.
    C. Abdomen uniform in color. ..... *simplex*, p. 355
    C′. Abdomen mottled uniformly with gray. ..... *maculatus*, p. 356
  B′. Color shining black, the lower margin of the pronotum, the posterior legs and the middle portion of the ovipositor sometimes lighter in color.. *nigra*, p. 355
A′. Smaller pronotum generally no more than 11 mm. in length.
  B. Usual color brown or green, the abdomen not marked with gray. *coloradus*, p. 356
  B′. Usual color varying shades of brown, the abdomen mottled with gray. *maculatus*, p. 356

The typical form, has for synonyms *purpurascens* Uhler and *similis* Scudder. Specimens taken at one locality, Fort Collins, Colorado, exhibit ovipositors nearly straight and scarcely longer than the posterior femora to quite strongly curved upward and considerably longer than the posterior femora. These specimens also vary in color from yellowish to dark shiny brown.

FIG. 47.—ANABRUS SIMPLEX. CERCUS OF MALE.

This form, as here considered, seldom has the pronotum less than 12 mm. long, rarely but 11.5. It ranges from the plains of Nebraska to California and occurs from a few hundred feet altitude to several thousands, in the mountainous districts of considerable elevation merging into the stunted form known as *coloradus*. The specimens occurring in Nebraska and other eastern localities are usually lighter in color than ones from the west, and the posterior femora seem to be somewhat less robust and a little shorter.

ANABRUS SIMPLEX var. NIGRA, new variety.

Description.—This is a form distinguished by its shiny black color. The lower margins of the lateral lobes of the thorax are sometimes yellowish and the posterior legs and the middle portion of the ovipositor of the females are often lighter in color. The subgenital lobes of the females reach the apex of the subgenital plate and the ovipositor is moderately upcurved and considerably longer than the posterior femora. A longer series would probably show variation in these respects as there is in the typical form.

Measurements.—Length, pronotum male 12.5–14 mm., female 11.5–14; posterior femora, male 20–21, female 20–24; ovipositor 23–26.

Type.—Cat. No. 10176, U. S. National Museum.

Specimens examined.—Two male, four females, Idaho; one female, Blue Lake, Idaho; one female, Plush, Oregon; two females, four males, Eddy, Route County, Colorado.

This is merely a color variety, and grades quite imperceptibly into the typical form.

ANABRUS SIMPLEX var. MACULATUS, new variety.

Description.—Averaging smaller than the typical form. The color varies from yellowish brown to dark brown, the abdomen mottled regularly with gray. The lower margins of the lateral lobes of the thorax is sometimes yellowish. The subgenital lobes of the female in all specimens examined extend to the apex of the subgenital plate; ovipositor but little or no longer than the posterior femora and usually considerably curved upwards.

Measurements.—Length, pronotum, male, 10–11 mm., female, 9.5–12; posterior femora, male, 17–17.5, female, 17–20; ovipositor, 17–20.

Type.—Cat. No. 10177, U. S. National Museum.

Specimens examined.—Two males, five females, Fort Walsh, British Columbia, September; eight males, six females, Mount Rainier, Washington, August 25; one female, Bismarck, North Dakota, July; one female, New Mexico; one male, one female, Nebraska, labeled Lincoln, but probably taken one hundred miles or more northwest of there in the sand hills.

The maculation of the abdomen of this form gives it somewhat the appearance of being hairy. The female from Bismarck, North Dakota, is labeled by Thomas as *purpurascens*. It is the one figured in Howard's Insect Book. The unusual color, especially of fresh specimens, gives this form quite a characteristic appearance. Intermediate forms, however, lead from it to typical *simplex*. The series taken on Mount Rainier by Mr. Burke was examined when quite fresh and the specimens were found to be quite uniform in size and coloration. The grayish mottling of the abdomen has a tendency to fade out in dried specimens. These Mount Rainier specimens were found singing in the sun about noon.

ANABRUS SIMPLEX var. COLORADUS Thomas.

Description.—A small subalpine or alpine form. The color of living specimens seems to be usually grass green, but there is variation in color here as in the typical form. The subgenital lobes of the female vary in backward extension, some reaching the apex of the subgenital plate and others falling somewhat short of it. The ovipositor is more or less upcurved and varies in length from slightly longer to much longer than the posterior femora.

Cabinet specimens of this form exhibit all shades of coloration. The type-specimens, which were preserved in spirits and probably

much discolored, are now in the National Museum. They are nearly yellow with the posterior portion of the upper part of the lateral lobes of the pronotum, just below the lateral carinæ, black, as are also the margins of the abdominal segments. Some specimens, probably ones killed soon after transformation, are wholly yellow, while others are nearly black.

Measurements.—Length, pronotum, male, 7–11.5 mm., female, 9–11.5; posterior femora, male, 12.5–19, female, 14–21; ovipositor, 16–24.

Type.—Cat. No. 1107, U. S. National Museum.

Specimens examined.—The types, two discolored alcoholic specimens, male and female, from "eastern Colorado," and specimens from Colorado—Pikes Peak, Manitou, Longs Peak, Palmer Lake, Colorado Springs, Lakespur, South Park, Ward, Livermore, and summit of Vega Pass; from Cumbres, New Mexico, southern Idaho, northern Utah, and Fort McLeod, British America. Also specimens referable to this form from Wallace County, Kansas, and Lincoln, Nebraska. These specimens represent the merging of this ordinarily higher altitude form with the ordinary prairie form. Specimens of *coloradus* from high altitudes are invariably smaller than those from places of less elevation. Thus the specimens from Livermore and Colorado Springs are decidedly larger than ones taken high up in the mountains. These larger specimens inhabiting the lower altitudes merge quite imperceptibly into typical *simplex*. *Coloradus* seldom occurs below 6,000 ft. altitude.

Anabrus simplex, with its several races, is, economically, our most important member of the subfamily Decticinæ. Great bodies at times march from their breeding places in neighboring hills into the surrounding cultivated fields, causing great damage. Such swarms are often several miles in extent, and usually, I believe, consist of the typical form with some of the variety *nigra*. Such an invasion occurred in Route County, Colorado, in 1904, and is thoroughly discussed by Gillette and Johnson in Bulletin No. 101 of the Colorado Experiment Station, where the habits and life history are ably described. Doten,[a] discusses the question of remedies, while a short summary of the subject is given by Aldrich in Bulletin No. 41 of the University of Idaho. The breeding habits are treated of by Gillette.[b] For a thorough study of this interesting species the above-mentioned articles, as well as other older ones, should be consulted.

This insect generally breeds in hilly places where vegetation is scarce, preferring clay soils containing surface cracks which facilitates the insertion of the ovipositor. In ovipositing, the female brings the tip of her ovipositor forward beneath the abdomen and forces it nearly perpendicularly into the ground. The eggs are chocolate

[a] Bulletin No. 56, Nevada Experiment Station.

[b] Entomological News, xv, pp. 321–324.

brown when first deposited, but soon dry to a grayish color. They are about one-fourth of an inch in length by one-sixteenth wide and are nearly straight. So numerous are the eggs, which are laid loose in the soil, the upper ones sometimes sticking partially above the surface, that as many as three thousand have been counted in a square foot of soil. A single female may lay over one hundred eggs, but the egg-laying period probably extends over a considerable period of time, as ova of various stages of development are found in the ovaries at one time. The copulation of this insect presents interesting features. The position of the male in copulation is curled beneath the female or lying on his back beneath her, being dragged about as she walks. The transference of seminal fluid inclosed in a sac is recorded as follows by Gillette in his article in Entomological News, from which many of the facts here stated were taken:

> While studying the habits of this wingless grasshopper, near Eddy, my attention was attracted by the large white masses of jelly-like material that were attached to the abdomens of the females just beneath the ovipositors. They had also been noticed by the ranchmen, who spoke of them as "white sacs" and "blubber." I concluded the phenomenon must be associated in some way with the process of fertilization, and began an investigation. By pinching the abdomens of several females having the white masses attached I found they could be removed without breaking or tearing any organ, and that they were held in place by the vulva, which grasped a small portion or lobe. Several examples of both sexes were then taken at random from the swarm, and their abdomens were opened in search of this body, but it was not found. I noticed, however, that the seminiferous tubules of the males were filled with a milky white fluid before copulation, and that after copulation they were empty and yellow in color. A male and female in copula were then separated, just before the close of the process and before the sperm mass had made its appearance. The male abdomen was then pinched, so as to crowd the contents toward the end, and a sperm mass, exactly like those taken from the females, was obtained. I therefore concluded that during copulation the males fill these sacs with seminal fluid and then transfer them bodily to the females, who seize them by two small lobes. The females carry these conspicuous white objects about for a time, extracting a portion, at least, of their contents for the fertilization of the ova. After two or three hours these masses disappear entirely, but whether the contents are largely taken in by the female or whether she rejects the greater portion after extracting the spermatozoa I did not determine.

Cabinet specimens occasionally retain the sacs mentioned in the above extract, such being true of a specimen of the variety *coloradus* from Larkspur, Colorado. The angular corners of the subgenital plate seem to aid the subgenital lobes in retaining the sac. I have seen similar sacs attached to the female of *scudderia furcata* Brunner. Gillette says that mating was apparently done mostly in the early morning, as the females carrying seminal sacs were most numerous about 9 or 10 o'clock in the forenoon, scarcely any occurring after midday. The egg-laying period seems to extend through July and August and well into September, the young hatching as early as March, and are often subjected to severe temperature, which, how-

ever, they are able to endure with little fatality. The young are thus described by Gillette from living specimens.

> When first hatched, the crickets are a light flesh color throughout, except the black eyes, but soon become quite black, with a broad, flesh-colored stripe the entire length of the back. Along the middle of this light dorsal stripe are two black lines separated by a narrow line of the flesh color. The hind margin of the cape, or pronotum, immediately above the front pair of legs, is very conspicuously light yellow, almost white. Antennæ somewhat longer than the body, and black.

The legs of the young nymphs are longer in proportion than in the adult forms, though Gillette does not mention this peculiarity in the above quoted description. The posterior femora of the young are more than two times as long as the pronotum, which is never the case in the adult form.

The adult males chirp in the morning hours, ceasing about 10 o'clock, except when disturbed by something, when they make a sharper note of warning, causing those in the vicinity to hop in various directions. Activity ceases at night, the insects usually retiring to rest beneath or in bushes. In 1879, Thomas stated that their activity is greater at night, but more recent observers say otherwise. I found the alpine form, *coloradus*, stridulating in the middle of the day, as I also observed the prairie form to do.

The food of this insect is varied. They will eat sage brush, but seem to prefer more succulent food, either wild or cultivated. Field grain and grasses, potatoes, and most garden truck are greedily devoured by them. Peas and timothy are said to be but little favored by them as articles of diet. They are not confined to a vegetable diet, being, in fact, rather partial to animal matter, especially disabled members of their own kind. Gruesome, indeed, are the feasts often held by these cannibals off an unfortunate brother or sister. Spent females, weakened by exertion of oviposition, often furnish a luxurious repast for other stronger individuals. Their cannibalistic habits are probably similar to those of *Peranabrus scabricollis*, a discussion of which appears under that species. Flesh of any kind is acceptable to the *Anabrus*, dead snakes being eaten as readily as cooked fish. Worms and various insects are eaten by them, and they have been observed to climb bushes to feed upon the cicadas, which they grasp by the wings. They are also fond of fresh horse manure, and also eat cow dung. In fact, they will eat nearly anything, and, as stated by Gillette, an insect with such food habits is not likely to die very soon of starvation.

While the *Anabrus* eats nearly anything that comes in its way, it is not itself exempt from being eaten. They are supposed to have at one time formed an article of diet among the Indians of the valley of the Great Salt Lake. They were eaten cooked or raw, with no other preparation than the removal of the head and legs. There are a number of natural enemies that prey on the *Anabrus*. Among animals seen eating them may be mentioned the bear and the wolf, and the

hog is said to be fond of them. Birds prey somewhat extensively upon them, the hawk, crow, ptarmigan, lark, grouse, gull, and blackbird being among those credited with eating them. A large toad has been reported as following creeks to feed upon the drowned specimens, while fish have been recorded as gorging themselves on the drowned crickets. No insect enemies are known, but specimens have been found infested internally with hair-worms. A large wasp, *Palmodes mœris* Kohl, preys upon the allied *Peranabrus scabricollis* and may also attack this insect, though no record of its doing so has yet appeared. Red mites have been recorded as occurring on the *Anabrus*.

When vast hordes of *Anabrus* appear, laying waste large areas of cultivated fields, they form a scourge not easily combatted. Everything in their line of march falls before their ravenous appetites. Bodies of water of considerable size are bridged by the thousands of the drowned and across march the millions. Armies of the advancing hordes often extend over a mile, the ground over which they move being literally covered by the slowly moving mass. The rate of travel is probably little more than one-half mile a day, though it has been recorded as twice that much. Since the earliest settlements the ranches of the arid west have suffered from the ravages of these insects, and portions of Idaho and neighboring States seem to suffer more or less nearly every year.

A number of remedies against this pest have been tried and recommended. The papers of Doten, Aldrich, and Gillette, above mentioned, should be read for information regarding various remedies. Herding the army off cultivated fields, fencing them out by means of vertical walls of tin, wood, oil-cloth or other material, killing the insects by poisons, trampling by sheep, crushing with rollers, trapping in vertical-sided trenches, and killing with oil have all been considered. The effectiveness of oil in killing the pests is a matter of some dispute. It seems as if the insects are able to resist quite thorough applications of even pure kerosene, recovering, according to Professor Gillette, after a moderate spraying, but dying when immersed in it. Poisons act too slowly to be of practical value in times of invasion. Herding and fencing are probably the best methods of warding off their attacks. The suggestion has been made of innoculating migrating hordes with fungus disease, but the dryness of the climate of the infested regions would scarcely favor the success of such experiments.

The insect figured by Woodworth in Bulletin No. 149 of the California Experiment Station, fig. 8*b*, as *A. simplex* is certainly not this species, but some long-legged dectician, probably a species of the genus *Cacopteris*.

ANABRUS CERCIATA, new species.

Description.—Pronotum with the lateral carinæ rounded; median carina scarcely indicated; disk with the posterior margin evenly rounded. Anterior tibiæ armed above with five spines on the outer carina and two or three on the inner. Cerci of the male as in fig. 48, the branches widely divergent, the lower branch the longer and curving perpendicularly downward, the tip inclined somewhat inward; the shorter branch directed inward at nearly right angles to the main body of the cercus and the tip curving downward; (fig. 48) cerci of the female long, basally swollen and apically attenuate, very sharply pointed. Subgenital lobes of the female slightly exceeding the subgenital plate. Ovipositor as long as the posterior femora, very slightly curved upwards.

Color brownish with obscure yellowish mottlings; lateral lobes of the pronotum not margined; ovipositor reddish-brown, darker at the tip.

Measurements.—Length, pronotum, male, 16–16.5 mm., female, 18; posterior femora, male, 27–29, female, 30; intermediate femora, male and female, 11; posterior tibia, male, 26–30, female, 29; intermediate tibia, male, 14, female, 12.5; ovipositor, 30.

FIG. 48.—ANABRUS CERCIATA. CERCUS OF MALE.

Types.—Cat. No. 10178, U. S. National Museum (male) and in the Academy of Natural Sciences of Philadelphia (female).

Specimens examined.—One male, Washington (Morrison); a second male from the same locality is in the Bruner collection, the source of the type, and a female in the collection of the Philadelphia Academy of Natural Sciences from the Le Conte collection taken on the Columbia River in Oregon.

This species is distinguishable at a glance from any of the other described species of the genus by the unusually large size, and the males are even more readily distinguished by the structure of the cerci.

ANABRUS LONGIPES, new species.

Description.—Head scarcely prominent, no broader than the anterior portion of the pronotum, into which it is quite deeply inserted; vertex moderately prominent, convex, not sulcate; first segment of the antenna scarcely half as large as the vertex as viewed from the front; eyes rounded, not prominent. Pronotum smooth, almost shiny; disk marked on the middle with two short posteriorly convergent sulci, sometimes united to form a U-shaped sulcus; posterior margin of the disk broadly rounded. Legs long, the posterior femora (fig. 49) more than twice as long as the pronotum and armed below with a few short stout spinules on each side; anterior tibiæ armed above on both margins, the outer margin with four or five spines, the inner with from one to three. Wings barely meeting above and not extending beyond

the pronotum in the female, in the male overlapping, strongly convex and extending a very little beyond the pronotum. Abdomen stout and plump, very inconspicuously carinate; supraanal plate of both sexes subtriangular, centrally depressed; subgenital plate of female broadly concave apically with the side angles sharp, elongate and bent inwards, of the male elongate and apically triangularly incised, the apical stylets missing from the only specimen seen; subgenital lobes of the female elongate, apically narrowly rounded, about two times as long as broad and reaching to the tip of the subgenital plate; cerci of the female simple, cylindrical, about two times as long as the basal width and apically pointed, of the male shaped as in *simplex*. Ovipositor very moderately curved upwards, about as long as the posterior femora.

Color dark brown with the top of the pronotum, at least the posterior half, generally yellowish and the posterior femora are

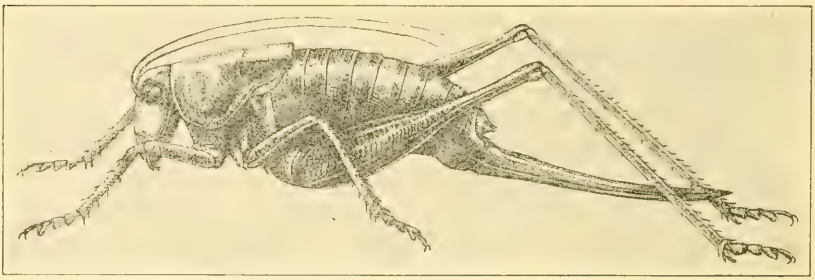


FIG. 49.—ANABRUS LONGIPES. ADULT FEMALE.

usually, but not always, yellowish, especially towards the apex; the face is yellowish brown and the abdomen is sometimes lighter on the basal half of each segment.

Measurements.— Length, pronotum, male, 12.25 mm., female, 12.5–13; posterior femora, male, 26,[a] female, 27–29; ovipositor, 26–28.

Type.—Cat. No. 10179, U. S. National Museum.

Specimens examined.—One male, two females, Pullman, Washington, August, taken by C. V. Piper.

The general structure of this long-legged species is so similar to *A. simplex* that the breeding habits are very probably as described under that species. The female quite likely carries the seminal sac of the male as described under *simplex*, as the structure of the subgenital lobes and plate seems fitted for the purpose of holding the sac as it is in that species.

PERANABRUS Scudder.

Peranabrus SCUDDER, Can. Ent., XXVI, 1894, pp. 178, 181; Guide N. A. Orth., 1897, p. 56; Cat. Orth. U. S., 1900, p. 77.—KIRBY, Syn. Cat. Orth., II, 1906, p. 192.

[a] The left hind leg is abnormal, the femur measuring barely 24 mm.

Description.—Head large and broad, slightly broader than the pronotum and quite prominent, vertex moderately prominent one-third as broad as the interocular space; eyes rounded, scarcely prominent. Pronotum large, posteriorly moderately produced, lateral lobes well developed, moderately declined and posteriorly sinuate; lateral and median carinæ present, dull but persistent, the former converging somewhat near the middle of the anterior fourth; disk scabrous, without distinct transverse sulci, truncate both in front and behind, sometimes slightly rounded or angulate behind. Abdomen plump, distinctly carinate dorsally. Legs short, the posterior femora less than two times as long as the pronotum, unarmed below or, rarely, with one or two very obscure short spines; anterior tibiæ armed above on the outer side only with from three to five spines. Wings as in *Anabrus*. Cerci of the female somewhat compressed basally, spically acute; of the male large, stout, apically somewhat depressed and broadened, the inner apical angle forming a short tooth with a sharp naked point (fig. 53); subgenital plate of the male apically triangularly incised, of the female with the apical incision somewhat broader with the lateral angles acute, somewhat as in *Anabrus*, and like that genus furnished at the base with a pair of subgenital lobes which, however, are here sharply angulate instead of rounded; supra-anal plate as in *Anabrus*. Ovipositor curved moderately upwards and considerably longer than the posterior femora.

Type.—*Thamnotrizon scabricollis* Thomas.

This genus very much resembles in general form the genus *Anabrus*. The scabrous pronotal disk, the shape of the male cerci, and the armature of the anterior tibiæ will serve to easily separate it from that genus. We have but one known species.

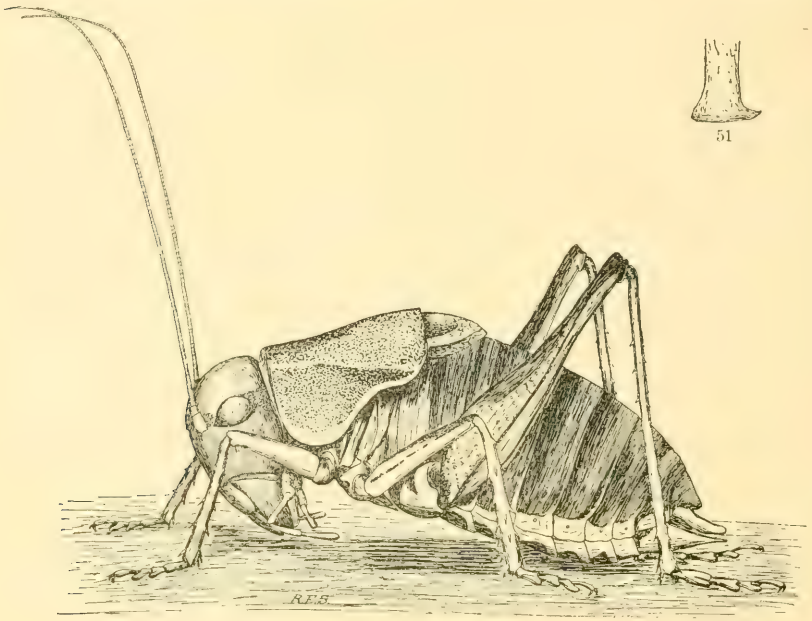
PERANABRUS SCABRICOLLIS Thomas.

Thamnotrizon scabricollis Thomas, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 441.—Glover, Ill. N. A. Ent., Orth., 1872, pl. xiii, fig. 6.

Peranabrus scabricollis Scudder, Can. Ent., XXVI, 1894, pp. 181, 183; Cat. Orth. U. S., 1900, p. 77.—Piper, Bull. No. 46, Div. Ent., U. S. Dept. Agric., 1904, pp. 60–61.—Snodgrass, Journ. N. Y. Ent. Soc., XI, 1903, pp. 183–188, pls. xii, xiii; XII, 1905, pp. 74–82, pls. i, ii.—Kirby, Syn. Cat. Orth., II, 1906, p. 192.

Description.—Head slightly broader than the anterior margin of the pronotum into which it is well indented; vertex moderately prominent; front broadly rounded, moderately full; eyes small, scarcely prominent; antennæ slender, the basal segment broad. Pronotum moderately large and considerably extended posteriorly, the lateral lobes well developed but not as deep as long, slanting very moderately, and the posterior margin quite strongly sinuate; lateral carinæ moderately prominent but dull, nearly straight, diverging from in front backwards; pronotal disk scabrous, subtectiform, broader behind

than in front, anteriorly and posteriorly truncate, without transverse sulci; median carina persistent but low and dull. Prosternum unarmed. Legs short, the posterior femora (fig. 50) much swollen on the basal three-fourths, less, or no more, than twice as long as the pronotum, rarely armed beneath and then with but one or two minute spines; anterior tibiæ armed above on the outer side only with from three to five spines. Wings as in *Anabrus*, except that those of the male are apically more pointed. Abdomen plump, carinate dorsally. Cerci of the female simple, pointed, rapidly tapering; of the male heavy, depressed at the tip and broadened, the inner angle forming a short, sharp incurved spine (fig. 51); subgenital plate triangularly



51

50

FIGS. 50, 51.—PERANABRUS SCABRICOLLIS. 50, ADULT MALE (AFTER SNODGRASS). 51, CERCUS OF MALE.

incised in the male, the terminal styles about four times as long as broad; subgenital plate of the female broadly incised; subgenital lobes of the female elongate triangular, more than twice as long as the basal breadth and tapering regularly to a point, often, in cabinet specimens, lying very close to, or apically curved under, the edge of the subgenital plate, the end of which it just reaches. Ovipositor moderately curving upwards, considerably longer than the posterior femora and apically pointed and unarmed. (Fig. 52).

Color dark brown or dark reddish brown, in cabinet specimens often discolored, being yellowish brown; the lateral lobes of the pronotum are margined below and behind with yellowish, and the elyta of the

males are bordered behind and on the sides with the same color. The under side of the body is light in color and the legs are often yellowish brown, the outer face of the posterior femora often spotted or mottled with black and yellowish brown.

Measurements.—Length, pronotum, male, 7.5–9.5 mm., female, 7.5–10.5; posterior femora, male, 14.5–18, female, 15–19; ovipositor, 20–24.

Type.—Cat. No. 1108, U. S. National Museum.

Specimens examined.—The male and female types from Montana, and specimens from the following localities in Washington: Baird (May), Coulee City, May 30 (Piper), and Blue Mountain, July 15.

This species is very nearly allied in general appearance as well as habits to *Anabrus simplex*. Like that species it often occurs in vast numbers, devastating cultivated crops. Such occurrences, however,

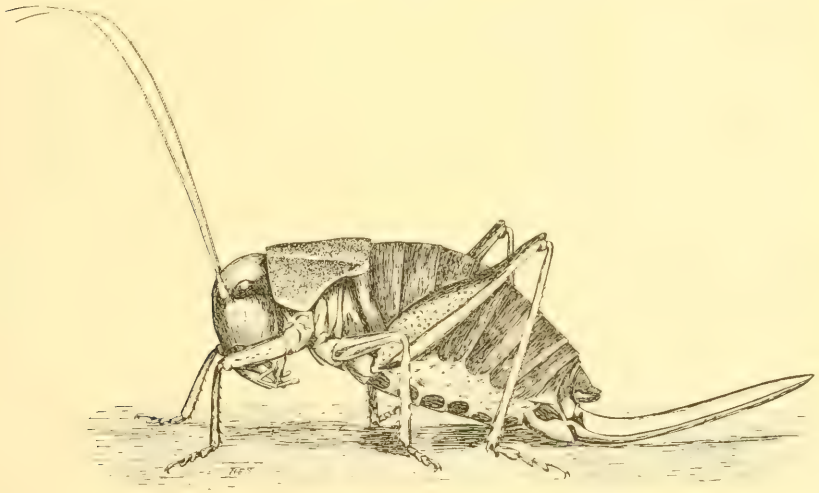


FIG. 52.—PERANABRUS SCABRICOLLIS. ADULT FEMALE (AFTER SNODGRASS).

have so far been reported only in the State of Washington. The same remedies apply to it as in the case of invasions by *Anabrus*. The internal anatomy of this insect is given by Mr. Snodgrass, as is also the habits and life history. The following notes are mostly taken from the articles of this writer:

The common name of "Coulee cricket" is often applied to this insect, suggested by the insect's partiality to regions in or about canyons known by that name. They seem to breed in desert lands, but often migrate into cultivated areas, there doing much damage. By the first of June most have reached the adult stage. When not migrating they move about or sit motionless under bushes. Their usual gait is a slow walk, but when frightened they will jump. They ordinarily walk at a rate of about ten feet a minute. When they leap they cover a distance of from three to four inches at a jump. They

seem perfectly void of fear, climbing all over one's person unless persistently brushed off. The usual chirps of the male are uttered in regular and rather slow succession, averaging between 90 and 100 beats a minute; when disturbed they stridulate sharply and more rapidly, with a decided angry tone. Like *Anabrus* this insect is omnivorous and shows the same decided cannibalistic tendencies, seeming especially fond of its own kind as an article of diet. Crops from specimens having fed on vegetable matter were filled with a green pasty mass, quite readily distinguished from the brown pulpy mass resulting from cannibalistic feasting.

Migrating bands seem to begin moving late in the afternoon, the fore part of the day being occupied in sitting still or walking aimlessly about. When traveling they move closely massed, a cricket to nearly every square inch of space, about fifteen crossing a given point every minute.

The mating habits are thus described by Snodgrass:

> From about 10 o'clock until noon mating takes place between the males and females. During this act the male is beneath the female. The former while courting the female chirps continually with his wings, and, advancing backwards and obliquely sideways towards the female from in front, tries to push his abdomen beneath hers. Sometimes the female makes no resentment, but often the male has his patience sorely tried. One was observed for twenty minutes attempting to make a female accept him before she finally did so.
>
> Although the male is the active party during courtship the fertilization of the female depends on an act of her own. The ovipositor is directed downward, or its tip braced against the ground; the opening of the bursa copulatrix behind the eighth sternum is then brought against the tip of the male's abdomen. After about five minutes a large white mass of tough albuminous matter is ejected by the male into the bursa copulatrix of the female. The pair then separate, but the white mass hangs from the abdomen of the female as a large bilobed appendage, and apparently causes her much annoyance.
>
> It is not evident what the function of this albuminous mass is, but it looks like simply a plug to close the bursa copulatrix. In the male a great mass of tubular accessory glands open into the ejaculatory duct, and it must be these glands that secrete the albuminous mass. The female often keeps the tip of her abdomen elevated to prevent the mass from dragging on the ground, for, being sticky when fresh, it becomes covered with bits of leaves and grains of sand. She attempts to rid herself of it by bending her head beneath the abdomen and chewing it off. Others assist her by eating at it until, after a short time, it is gone. Seldom is one seen in the afternoon with the mass adhering, while it is commonly present on females in the morning between 10 and 12 o'clock. No cases of mating were ever observed in the afternoon.

It will be noted that the seminal sac as described by Gillette under *Anabrus simplex* and the albuminous mass as described above by Snodgrass are analogous, and the mating habits of the two insects are very similar. The egg laying seems to be principally carried on in the late afternoon. It is thus described by Snodgrass:

> At about 5 o'clock the females begin laying eggs, and continue to do so until late in the evening. While ovipositing the female most commonly assumes an upright

position, standing upon her hind legs beside a small bunch of grass and grasping the blades with the other legs for support. The ovipositor is carefully forced down into the ground to its base. Strong peristaltic constrictions of the abdomen now take

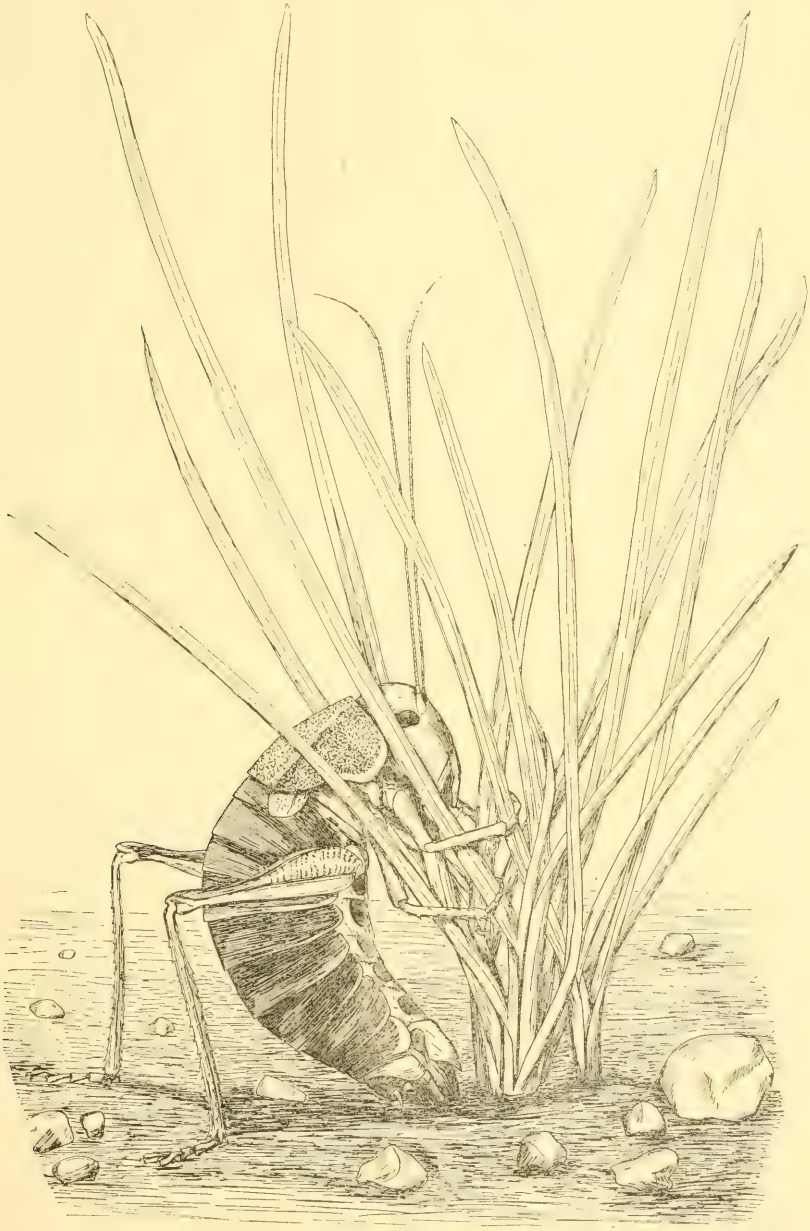


FIG. 53.—PERANABRUS SCABRICOLLIS. FEMALE OVIPOSITING (AFTER SNODGRASS).

place for a minute or so, and then the ovipositor is withdrawn. Immediately, however, it is either poked down again into the same hole or thrust into a new place

beside the first one. Thus the female continues, placing a few eggs in one hole, a few in another and so on, until a great many are laid about the roots of the same clump of grass (fig. 53.) Often she quits one place and goes off some distance to another. In the migrating bands the females have much difficulty in depositing their eggs on account of the jostling and pushing of those moving past. Sometimes a female, while ovipositing, rests on the ground in the natural position and inserts the ovipositor by drawing the tip forward beneath her and then thrusting it downward into the ground.

The eggs are not inclosed in a case, each being entirely free and separate from the others. They are discharged from the tip of the ovipositor, passing slowly along its entire length, one at a time, by a slight movement of the blades upon one another. The latter spread apart at the tip as the egg passes out.

After laying her eggs the female apparently weakens and dies during the day following.

By the middle of July the insects are said to be mostly dead. Toward the last the males are more numerous than the females by reason of many of the latter having been eaten by their fellows when weakened from ovipositing.

A large Pompilid wasp, *Palmodes moris* Kohl, was observed to store its burrow with *Peranabrus*. Animals, birds, and reptiles will probably be found to feed upon this insect, as they are known to do on *Anabrus*.

Prof. C. V. Piper tells of statements made by Washington farmers to the effect that hogs are sometimes killed by eating this insect, the stomach walls being punctured by the sharp ovipositors of the females.

ATELOPLUS Scudder.

Ateloplus SCUDDER, Can. Ent., XXVI, 1894, pp. 179, 182 (invalid; no described species mentioned); Guide Orth. N. A., 1897, p. 57 (invalid; no described species mentioned); Cat. Orth. U. S., 1900, pp. 79, 98.—KIRBY, Syn. Cat. Orth., II, 1906, p. 195.

Description.—Head moderately small, not prominent; vertex narrow, about one-fourth as broad as the interocular space; eyes moderately prominent, rounded; antenna slender, the basal segment broad, broader than the vertex. Pronotum small and very moderately produced posteriorly; lateral lobes very poorly developed, uniformly rounded into the disk, no trace of lateral or median carinæ; posterior margins of the lateral lobes scarcely sinuate; pronotal disk rounded, smooth, with a more or less distinct transverse sulcus across the middle of the anterior half, often not, or scarcely, visible; anterior and posterior margins of the disk subtruncate or very broadly rounded. Prosternum unarmed. Legs moderately stout, posterior femora more than two times as long as the pronotum, much swollen in the basal three-fourths and armed below with a few stout spines on both margins; anterior tibia armed above on the outer side only, usually with a single apical spine, sometimes with two or three spines. Wings concealed beneath the pronotum in the female, the elytra in the male projecting one-half their length beyond the pronotum. Cerci simple

and straight in the female, in the male armed on the inner side with a tooth or projection, or curved inwards apically. Supraanal plate triangular in both sexes; last dorsal segment of the abdomen of both sexes triangularly or roundly incised; subgenital plate of the male longer than broad, obtuse triangularly incised apically and ventrolaterally carinate, the carinæ terminating at the base of the apical styles; subgenital plate of the female proportionately shorter than that of the male, apically less angularly incised and without apical styles. Ovipositor about as long as the posterior femora or considerably shorter, more or less curved upward.

Type.—*Ateloplus notatus* Scudder.

The armature of the anterior tibiæ in this genus, like those of *Idiostatus* and a few others, is variable, as will be seen from the discussion of the following species. A sufficiently large number of specimens of any of the species for study might show the number of dorsal spines on the outer margin of the anterior tibiæ to vary in number from one to three, though none have been seen with two spines. Color is somewhat variable, but fortunately the male cerci form an excellent synoptic character, separating the genus into three unquestionably distinct species, which, together with one species erected on the female only, may be separated by the following key:

KEY TO THE SPECIES OF ATELOPLUS.

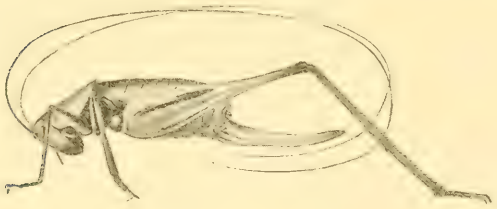
A. Larger; cerci of the male not shaped as fig. 59; ovipositor but little more than three-fourths as long as the posterior femora.
  B. Cerci of the male about four times as long as broad, armed on the inner side with a stout preapical spine (fig. 55); posterior femora of both sexes tipped with black ..... *notatus*, p. 369
  B′. Cerci of the male no longer than broad, armed on the inner side at the apex with a very small, fine tooth (fig. 58); posterior femora of neither sex tipped with black ..... *schwarzi*, p. 372
A′. Smaller; cerci of the male, that of *minor* unknown, apically curved inwards, a slight shoulder on the outer side (fig. 59); ovipositor nearly as long as the posterior femora, decidedly more than three-fourths as long.
  B. Color yellowish brown, ovipositor more strongly curved upwards.. *luteus*, p. 373
  B′. Color dark brown, ovipositor less strongly curved upwards ..... *minor*, p. 371

ATELOPLUS NOTATUS Scudder.

Ateloplus notatus Scudder, Cat. Orth. U. S., 1900, pp. 79, 98, pl. II, fig. 3.—Kirby, Syn. Cat. Orth., II, 1906, p. 195.

Description.—Head not prominent, deeply inserted into the pronotum, the anterior border of which projects slightly over the base of the head; vertex broad, the interocular space as broad as twice the width of one of the eyes; front not greatly convex; eyes moderate in size, moderately prominent; antennæ long and slender, more than twice as long as the body. Pronotum moderately produced posteriorly, the lateral lobes shallow, not more than one-half as deep as the pro-

zonal width, slanting, posteriorly scarcely or but very slightly sinuous; lateral and median carinæ absent; prozona broad, broadly convex, cut at the middle of the anterior half by a T-shaped transverse sulcus, anterior margin broadly rounded, the posterior margin truncate. Prosternum unarmed. Abdomen rounded, not carinate dorsally; ovipositor short, scarcely more than three-fourths as long as the posterior femora, curved gently upwards and apically smooth, without serrations; cerci simple, about three times as long as the basal width, rapidly and quite gradually tapering to a sharp point in the female, in the male about four times as long as the basal width, cylindrical, blunt apically and furnished in the inner side with a large, naked-pointed, preapical tooth (fig. 55); supraanal plate triangular in both sexes, nearly concealed in the male, more conspicuous in the female, dorsally sulcate; last dorsal segment roundly sulcate apically in the female and triangularly notched in the male, the projections acute in both sexes; subgenital plate of the male longer than broad, obtuse angularly incised apically and ventro-laterally carinate, the carinæ terminating on either side of the apical incision and from their extremity arise the short and bluntly terminated apical styles; of the female proportionately much shorter, apically less angularly incised and without lateral carination or apical styles. Wings of both sexes and the elytra in the female aborted, in the male the elytra project beyond the pronotum a distance equal to one-half their width. Legs moderately short and stout, anterior coxal spines long and sharp; femora ventrally armed with a few short spines, the anterior and intermediate ones with two or three, usually on the posterior margin only, rarely unarmed; posterior femora parallel on the apical third and armed with a few spines on both margins below, the geniculations blunt, laminate and curved inwards; tibiæ armed above and below, the anterior ones with a single preapical spine above on the outer margin in the female but in the male there are sometimes three; the intermediate tibiæ generally have four spines on the posterior border above and one or two on the anterior margin; posterior tibiæ armed below for three-fourths of their length with small spines placed far



54

55

FIGS. 54, 55.—ATELOPUS NOTATUS. 54, ADULT FEMALE (AFTER SCUDDER). 55, CERCUS OF MALE.

apart and arranged in two rows of six or eight spines each, and armed above for nearly their entire length with two rows of close set, short, stout spines.

General color light wood-brown. The top of the head is generally marked longitudinally with obscure stripes and the pronotum is ornamented above by faint clepsydrate markings and with a chestnut brown stripe down the middle and, in the female, extending along the back to the tip of the abdomen. The posterior femora are marked longitudinally on the outer face with a black line and the tip is black, as is also the base of the corresponding tibiæ. This femoral coloration is present in both sexes and will probably prove more constant than the body coloration. The ovipositor is infuscated apically.

Measurements.—Length, pronotum, male, 7 mm., female, 7; elytra, male, 1.5; posterior femora, male, 18, female, 18.5; ovipositor, 12.5; width, pronotum at posterior margin, male, 5, female, 5.

Type.—Cat. No. 5735, U. S. National Museum.

Specimens examined.—One adult female (fig. 54), the type, from San Diego, California (Orcutt), and an immature male from Indio, California, June 5 (Caudell). Through the courtesy of Prof. F. H. Snow I have been enabled to study an adult male from Bill William's Fork, Arizona (Snow).

The above-mentioned adult male agrees with the female type except as pointed out in the above description. It may eventually prove wrongly associated, in which case it will represent a new species, for it is certainly not conspecific with any of the three following forms. The immature male from Indio was taken under loose bark of a spiny tree standing alone in the desert. The cerci of this young specimen are proportioned about like those of the adult, but the inner tooth is scarcely indicated. The anterior tibiæ are armed above with a single preapical spine on the outer margin like that of the female.

The insect figured by Woodworth in Bulletin No. 142 of the California Experiment Station as *A. notatus* is either not this species or an unusually poor figure, the pronotum being figured with lateral carinæ, which is certainly not true of the insect now under discussion.

ATELOPLUS MINOR, new species.

Description.—Female, male unknown. Related structurally to the preceding species, but differs in the following particulars: The ovipositor is not so decidedly curved upward, the anterior

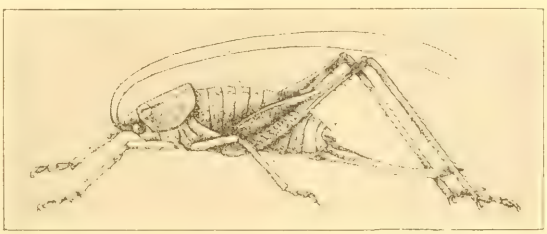


FIG. 56.—ATELOPLUS MINOR. ADULT FEMALE.

tibiæ are armed above on the outer margin with but one spine, the color is a dark brown with lighter mottlings, and the size is still smaller.

Measurements.—Length, pronotum, 5 mm.; posterior femora, 13; ovipositor, 12.5; width, pronotum at posterior margin, 3.75.

Type.—Cat. No. 10182, U. S. National Museum.

Specimens examined. The type (fig. 56), one female, Oracle, Arizona, June 29 (Schwarz).

ATELOPLUS SCHWARZI, new species.

Ateloplus notatus CAUDELL (not Scudder), Proc. U. S. National Museum, XXVI, 1903, p. 808.—REHN (not Scudder), Proc. Acad. Nat. Sci. Philad., 1904, p. 574.

Description.—In general size and appearance resembling *A. notatus*, but differs in the following particulars: The cerci of the male are short, being about as broad as long, and are armed at the tip with a very small, inconspicuous blackish tooth (fig. 58); the cerci of the female are about the same length as in *notatus*, but taper more abruptly, being somewhat bulbous basally. The last dorsal abdominal segment of both sexes is more acutely cleft than in *notatus* and the projections more elongate. Legs armed about as in *notatus*, but the anterior tibiæ of both sexes in all specimens examined are armed above with a single subapical spine. Color like that of *notatus*, except the dorsal stripe is not present in either sex and the posterior femora are not tipped with black.

FIGS. 57, 58.—ATELOPLUS SCHWARZI. 57, CERCUS OF IMMATURE MALE. 58, CERCUS OF ADULT MALE.

Measurements.—Length,[a] pronotum, male, 6.5 mm., female, 7–7.5; posterior femora, male, 15, female, 19–20; ovipositor, 14–15; width, pronotum at posterior border, male, 4.5, female, 5.5.

Type.—Cat. No. 10180, U. S. National Museum.

Specimens examined.—One adult male, one adult female, types, and one immature female from Tinajas Altas, Arizona (McGee); one adult female, one immature male and two immature females, Hot Springs, Arizona, June 21 (Barber and Schwarz); one immature male, Santa Rita Mountains, Arizona, June 22 (Barber and Schwarz); and one immature female, Phoenix, Arizona (Cordley).

This species superficially resembles *notatus*, but the black-tipped femora of the latter and, especially, the form of the male cerci very readily serve for their separation. The cerci of immature female specimens of *schwarzi* often taper gradually as in *notatus* and variation will probably be found to exist in this respect even in mature specimens. The cerci of the immature males are essentially as in the adult specimens (fig. 57).

[a] The measurements of the female are from two adult specimens, the minimum measurements being taken from the type.

ATELOPLUS LUTEUS, new species.

Description.—A much smaller and more slender appearing insect than *A. notatus*. The anterior tibiæ of both sexes are armed above on the outer margin with three spines. The general color is yellowish brown, much lighter than in the preceding species. The female has a black dorsal line extending from the front of the pronotum to the tip of the abdomen composed of two slender lines nearly touching. This dorsal line is not present in the male. The posterior femora are not tipped with black and the outer face is not marked with a dusky line except very obscurely so in the male. The most striking peculiarities of this species, however, lie in the genitalia. The cerci of the female are similar to those of *A. notatus*, but those of the males are strikingly different, being curved inward apically and with a slight shoulder on the outer side (fig. 59). The ovipositor is very nearly as long as the posterior femora, being decidedly more than three-fourths as long, as opposed to the two previous species where it is scarcely more than three-fourths as long as the posterior femora. The ovipositor is curved very decidedly upward and is scarcely at all infuscated apically.

FIG. 59.—ATELOPLUS LUTEUS. CERCUS OF MALE.

Measurements.—Length, pronotum, male, 5 mm., female, 6; posterior femora, male, 14, female, 15.5; ovipositor, 15; width, pronotum at the posterior border, male, 3.5, female, 4.5.

Type.—Cat. No. 10181, U. S. National Museum.

Specimens examined.—The types, one male, one female, Mohave, Arizona (Wickham).

The small size, the longer ovipositor, and especially the form of the cerci of the male will serve to differentiate this species from the preceding ones.

IDIOSTATUS Pictet.

Idiostatus PICTET, Mem. Soc. Phys. Genev., XXX, 1888, p. 63.—SCUDDER, Can. Ent., XXVI, 1894, pp. 178, 181; Guide N. Amer. Orth., 1897, p. 56; Cat. Orth. U. S., 1900, p. 78.—KIRBY, Syn. Cat. Orth., II, 1906, p. 193.

Cacopteris SCUDDER, Can. Ent., XXVI, 1894, pp. 178, 181 (invalid; no species included); Guide N. Amer. Orth., 1897, p. 56 (invalid; no species included); Proc. Amer. Acad. Arts Sci., XXXV, 1899, p. 87; Cat. Orth. U. S., 1900, p. 78.—KIRBY, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Head moderate in size, inserted well into the pronotum and scarcely prominent; vertex moderately narrow, about one-third as broad as the interocular space; eyes rounded and quite prominent. Pronotum fairly large and moderately produced posteriorly; lateral lobes variously developed, in some species being well developed and in others poorly so, but never as shallow as in the genus *Atcloplus*, moderately declivent and with or without posterior sinus;

lateral carinæ dull, rarely at all developed on the anterior half and then very inconspicuous; median carina absent or obscurely indicated on the posterior portion of the pronotum; disk posteriorly somewhat flattened or uniformly rounded, anteriorly truncate, posteriorly truncate, subtruncate or somewhat rounded. Prosternum unarmed. Wings lateral and but little extended beyond the pronotum in the female, in the male overlapping above and usually extending beyond the pronotum a distance equal to one-half or more than one-half the length of the pronotum. Legs long, the posterior femora more than two, usually three and sometimes four, times as long as the pronotum, much swollen on slightly more than the basal half and armed below on both margins with a few small spines; anterior tibiæ armed above on the outer side alone with three or four spines or armed on both outer and inner margins, the inner margin, when spined, with two to three spines. Abdomen moderately full and with or without dorsal carina; cerci simple in the female, in the male of various forms, armed on the inner side with a tooth or projection; supraanal plate[a] small, triangular and usually hidden beneath the last abdominal segment, which, in the male, is apically cleft, the incision linear, V-shaped, U-shaped or broadly rounded; subgenital plate of the female narrowly cleft, of the male triangularly cleft with the lateral angles terminating in apical styles. Ovipositor of various lengths, straight or curved slightly upwards on downwards.

Type.—Idiostatus californicus Pictet. (=*hermanii* Thomas.)

This is an interesting genus of apparently rare insects occurring in the western and southwestern United States. Little is known of the habits of the various species and some confusion has existed regarding the status of certain forms. The synonomy of Scudder's genus *Cacopteris* with *Idiostatus* is very certain as a type of *Cacopteris*, *C. aequalis*, has been seen and compared with the type of *Idiostatus* and found to be generically similar. The pronotum of *aequalis* is as angulate posteriorly and the median carina there as distinctly indicated as in *hermanii*.

The armature of the anterior tibiæ in this genus is unusual in as much as those of the two sides of a single specimen may vary, one being armed above on both margins and the other on the outer margin only. When long series of specimens are studied nearly all the species will probably be found to exhibit more or less variation in this respect.

As a whole *Idiostatus* is a very heterogeneous genus, but the various types are apparently unworthy of generic distinction, their differences being of insufficient importance. Three types of ovipositor, straight,

[a] Scudder, Proc. Amer. Acad. Arts Sci., XXXV, 1899, p. 87, designates what I call the last abdominal segment as the supraanal plate. In this matter Scudder is very surely wrong, the true supraanal plate being always present but nearly or entirely concealed beneath the last abdominal segment.

curved upwards and curved downwards, occur, but the degree of curvature is slight and valueless as a character of more than specific value.

As stated under the discussion of *Eremopedes*, there is some relationship between that genus and *Idiostatus*.

The species of *Idiostatus* are quite numerous as compared with most of our Dectician genera, and to facilitate their easy differentiation two tables are given, one of the males and one of the females. The following tables have been prepared with considerable care, and, I trust, will be found as functionable as compatible with the classifactory difficulties of the objects treated.

KEY TO THE SPECIES OF IDIOSTATUS—MALES.

(Males unknown of *femorata* and *variegata*.)

A. Cerci round or somewhat depressed, apically very unlike that of *inermis* as tabulated under the alternate category.
  B. Cerci with an inner tooth, not like fig. 61.
    C. Cerci beyond the tooth short and triangular or swollen, not like fig. 64.
      D. Tooth of the cerci somewhat incurved apically; cerci between the tooth and the tip concave, figs. 66, 67.
        E. Cercal tooth apically sharp and slender, no more than one-fourth as thick as the apical portion of the cercus itself.
          F. Smaller, total length 20 mm., of pronotum 6–8 mm. ... *hermanii*, p. 381
          F′. Larger, total length 30 mm., of pronotum 9–10 mm. .. *bilineatus*, p. 379
        E′. Cercal tooth apically less sharp, thicker than the apical portion of the cercus itself ..... *fuscopunctatus*, p. 382
      D′. Tooth of cerci not incurved; cerci between the tooth and the tip straight or convex, figs. 70, 72.
        E. Tooth of cerci triangular; cerci beyond the tooth acute triangular, fig. 70 ..... *rehni*, p. 382
        E′. Tooth of cerci slender; cerci beyond the tooth swollen, fig. 72. *elegans*, p. 384
    C′. Cerci beyond the tooth long and slender, much longer than the tooth itself, fig. 64 ..... *sinuata*, p. 378
  B′. Cerci with an outer tooth or shoulder, like fig. 61.
    C. Apical projections of the last abdominal segment triangular, short, separated by a V-shaped cleft, fig. 63 ..... *nevadensis*, p. 378
    C′. Apical projections of the last abdominal segment slender, accuminate, separated by a U-shaped cleft, fig. 62 ..... *æqualis*, p 376
A′. Cerci basally somewhat compressed and apically forming two depressed incurved teeth, fig. 73 ..... *inermis*, p. 386

KEY TO THE SPECIES OF IDIOSTATUS—FEMALES.

(Females unknown of *nevadensis*, *sinuata*, and *fuscopunctata*.)

A. Ovipositor almost as long, or longer than, the posterior femora.
  B. Size smaller and more slender, the pronotum less than 9 mm. in length rarely, *rehni* and *hermanii* more than 6 mm.
    C. Ovipositor straight or curved gently upwards; pronotum, except in *hermanii*, less than 6 mm. in length.
      D. Larger, pronotum more than 7 mm. in length ..... *hermanii*, p. 381

D′. Smaller, pronotum no more than 6 mm. in length, usually less.
E. Posterior femora less than four times, usually but three times, as long as the pronotum ..... *inermis*, p. 386
E′. Posterior femora four or more times as long as the pronotum. *æqualis*, p. 376
C′. Ovipositor apically curved somewhat downwards; pronotum usually more than 6 mm. in length ..... *rehni*, p. 382
B′. Size large and bulky, the pronotum 9 mm. or more in length.
C. Larger, the posterior femora more than 25 mm. in length ... *bilineatus*, p. 379
C′. Smaller, the posterior femora no more than 25 mm. in length. *elegans*, p. 384
A′. Ovipositor much less than the posterior femora in length.
B. Smaller, posterior femora more than four times as long as the pronotum. *femorata*, p. 387
B′. Larger, posterior femora less than four times as long as the pronotum. *variegata*, p. 387

IDIOSTATUS ÆQUALIS Scudder.

Cacopteris æqualis SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 88, 92; Cat. Orth. U. S., 1900, p. 78.—WOODWORTH, Bull. No. 142, Cal. Exp. Sta., 1902, p. 15.—KIRBY, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Head scarcely prominent, quite deeply inserted into the pronotum; vertex about one-third as broad as the interocular space and quite prominent; eyes rounded, not very large but protrudent, being decidedly prominent; basal segment of the antennæ enlarged and broad but scarcely one-half as large as the vertex as viewed from in front. Pronotum moderate in size; lateral lobes well developed, nearly as deep as long, almost vertical and very slightly sinuate posteriorly; lateral carinæ scarcely indicated except on the posterior third where they are present, usually distinct but never sharp; median carina present only on the posterior fourth of the pronotum and there very blunt and indistinct; pronotal disk rounded, scarcely perceptibly tectate, without transverse sulci or with a very obscure broad shallow one across the posterior portion, truncate anteriorly and posteriorly. Legs long, the posterior femora about four times as long as the pronotum and much swollen on a little more than the basal half, armed below with a few sharp, short, stout black spines; anterior tibiæ armed above on both margins, three spines on the outer margin and two on the inner. Elytra of the male (fig. 60) ample, projecting beyond the pronotum a distance about equal to the pronotal length, of the female forming widely separated rounded pads which project scarcely their own width beyond the pronotum. Abdomen moderately plump, scarcely carinate; subgenital plate deeply and linearly cleft in the female, in the male triangularly incised apically, the terminal styles about four times as long as broad; last dorsal abdominal segment of the male apically furcate, the angles elongate, extending to about the tip of the subgential plate, and sharp, with the incision U-shaped (fig. 62) cerci of the female about three times as long as the greatest breadth,

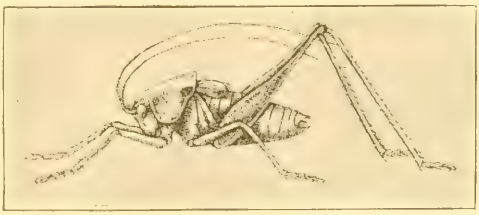
much swollen on the basal two-thirds, the apical third rapidly tapering in the basal portion, apically pointed; cerci of the male rounded, apically slightly depressed with the tip attenuate, bent inwards and slightly pointed, on the outer side about the middle furnished with a blunt shoulder or short projection (fig. 61). Ovipositor almost straight, very slightly curved upwards and as long, or very nearly as long, as the posterior femora.

Color dark or light yellowish brown; the sides of the pronotum just below the short blunt lateral carinæ is usually shiny black. The tegmina of the males are generally yellowish brown with a round black spot on the outer apical margin of each.

Measurements.—Length, pronotum, male, 4.5–5.5 mm., female, 5.25–6; elytra, male, 3.5–5, female, 1–1.5; posterior femora, male, 18–21, female, 20–25; ovipositor, 20–24.

Types.—Cat. No. 10183, U. S. National Museum, and in the collections of S. H. Scudder and A. P. Morse.

Specimens examined.—Various specimens from California and a female from Arizona. All the types are from California. Besides a female type from Cahon Pass, California, the National Museum contains two males and two females, all from Los Angeles County, California, except one male which is labeled simply California. One adult female from Claremont, California, and two immature females from San Bernardino County, California, taken in May, are also in the National collection. Bruner has recently contributed a female specimen from Arizona (Dunn).



60

61

62

FIGS. 60, 61, 62.—IDIOSTATUS ÆQUALIS. 60, ADULT MALE. 61, CERCUS OF MALE. 62, LAST DORSAL ABDOMINAL SEGMENT OF MALE.

An immature male in the Morse collection shows the elytra not projecting beyond the pronotum but with cerci essentially as in adult individuals. The immature female often has the ovipositor considerably longer than the posterior femora, one in the Morse collection having the ovipositor 22 mm. in length while the posterior femora measures but 17.5 mm.

IDIOSTATUS NEVADENSIS Scudder.

Cacopteris nevadensis SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 88, 91 (male, not female); Cat. Orth. U. S., 1900, p. 78.—KIRBY, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Male, female unknown. Very similar in structure and appearance to *C. æqualis*. The anterior tibiæ are armed as in *æqualis* but the posterior femora are relatively a little shorter. The lateral lobes of the pronotum are well developed but are less sinuate posteriorly than in *æqualis*, being practically without any trace of sinus. The elytra are essentially as in *æqualis* and, like those of that species, have the outer apical angles marked by a black spot. The cerci are like those of *æqualis* but the structure of the last dorsal segment of the abdomen is quite different, the apical denticulations being short, not reaching as far back as the tip of the subgenital plate, and triangular, not elongate, and the intervening sinus is V-shaped (fig. 63).

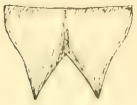


FIG. 63.—IDIOSTATUS NEVADENSIS. LAST DORSAL ABDOMINAL SEGMENT OF THE MALE.

Measurements.—Length, pronotum, 5 mm.; posterior femora, 18; elytra, 3.

Type.—In the Scudder collection.

Specimens examined.—Two males, Ruby Valley, Nevada (Ridgeway).

The female associated with these males by Scudder, but which he suggested might not belong here, is really the female of *I. inermis*, which see.

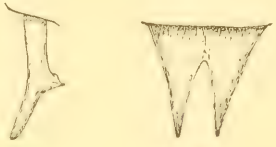
This species is very closely allied to *æqualis* and may eventually prove to be a form of that species. The structure of the last abdominal segment, however, seems to indicate quite strongly their distinctness.

IDIOSTATUS SINUATA Scudder.

Cacopteris sinuata SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 88, 90; Cat. Orth. U. S., 1900, p. 78.—KIRBY, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Male; female unknown. Head moderately deeply inserted into the pronotum, scarcely prominent; vertex narrower than in *æqualis*, being scarcely more than one-fourth as broad as the interocular space; eyes rounded and quite prominent; basal segment of the antennæ broad and about as large as the vertex when viewed from in front. Pronotum of medium size and moderately produced posteriorly; lateral lobes not well developed, being nearly twice as long as deep, moderately declivent, posterior margin slightly sinuate; lateral and median carinæ not indicated, the position of the former faintly represented by a slight squareness of the pronotum at that point; disk broadly rounded, without transverse sulci, subtruncate in front and behind. Legs moderately long, the posterior femora absent in the

only specimens examined; anterior tibiæ armed above on the outer side only with three spines. Elytra as in *æqualis* but extending beyond the pronotum a distance scarcely more than one-half the thoracic length and without a black spot on the outer apical angle. Subgenital plate as in *æqualis* but the last abdominal segment is between that species and *nevadensis*, the apical denticulations being almost as elongate as those of *æqualis* and the intervening sulcus V-shaped as in *nevadensis* (fig. 65). The cerci are very different from those of the preceding species; here the inner tooth is short and placed about the center and the tip of the cercus is nearly in a line with the basal portion (fig. 64). The color is a yellowish brown with darker mottlings on the legs and pronotum; elytra light brown with the membraneous portion black, the outer apical angles not marked by a black spot.



64 65

FIGS. 64, 65.—IDIOSTATUS SINUATA. 64, CERCUS OF MALE. 65, LAST DORSAL ABDOMINAL SEGMENT OF THE MALE.

Measurements.—Length, pronotum, 6 mm.; posterior femora, 20; elytra, 3.5.

Type.—In the Scudder collection.

Specimens examined.—Two males, Fort Whipple, Arizona (E. Palmer).

The most striking characters of this species is the poorly developed lateral lobes of the pronotum, the absence of any lateral carinæ and the structure of the cerci. This species resembles very much the *Eremopedes scudderi* of Cockerell, and it may belong to *Eremopedes* rather than to *Idiostatus*.

IDIOSTATUS BILINEATUS Thomas.

Steiroxys bilineata THOMAS, Rep. U. S. Geol. Surv. W. 100 Mer., V. 1875, p. 905.
Idiostatus bilineatus SCUDDER, Can. Ent., XXVI, 1894, pp. 181, 183; Cat. Orth. U. S., 1900, p. 78.—WOODWORTH, Bull. No. 142, Calif. Exp. Stat., 1902, p. 15.—KIRBY, Syn. Cat. Orth., II, 1906, p. 193.

Description.—Head of medium size, moderately inserted into the pronotum; fastigium considerably produced, apically as broad as one of the eyes; front slightly convex. Eyes not very prominent, round. Pronotum large, posteriorly produced and inclined upward, especially in the male where they cover the base of the wings. Lateral lobes well developed, about two-thirds as deep anteriorly as long and with scarcely any sinus, almost vertical with very broadly rounded lateral carinæ, not present anteriorly; median carina merely indicated posteriorly; disk moderately transversely convex, smooth, without sulci, truncate both anteriorly and posteriorly, sometimes slightly rounded behind. Abdomen smooth, without carina, thick and heavy, somewhat as in the genus *Anabrus*. Ovipositor nearly straight, slightly curved upward, as long as the posterior femora and apically unarmed. Cerci

of the female about three times as long as the basal width, uniformly tapering, of the male (fig. 66) broad and stout, separated at the base by a space about one-half as wide as the basal breadth of one, the inner tooth slender and much less in diameter than the apical portion of the cercus; last dorsal segment of the abdomen apically concave and depressed, forming two small rounded lobes. Elytra as broad as and more than one-half as long as the pronotum, and overlapping above in the male, in the female mere lateral pads. Legs with the anterior coxal spines long and distinct; posterior femora as long as the body, about three times as long as the pronotum, stout, swollen on the basal two-thirds and without genicular spines; anterior tibiæ spined above on the outer side with three spines; intermediate tibiæ spined above on both margins; posterior femora and tibiæ armed below with a row of short, dull, black spines on both carinæ.

FIG. 66.—IDIOSTATUS BILINEATA. CERCUS AND LAST DORSAL ABDOMINAL SEGMENT OF MALE.

Color (alcoholic), after Thomas.

Dorsal portions throughout pale olive, striped with yellowish lines. Two rather narrow yellowish lines (one from each eye) extend back along the entire length to the tip of the abdomen; each abdominal segment is margined posteriorly with a quite narrow yellowish line; the lateral margins are marked with a somewhat broader line of the same color. Face and entire ventral surface pale yellow. Legs purplish externally. The olive of the abdomen and pronotum is more or less slightly tinged with rufous near the margins of the spaces.

I have seen no material fit for study with relation to coloration.

Measurements.—Length, pronotum, male, 9 mm., female, 10; posterior femora, male, 24.5–26, female, 28–31; elytra, male, 5.5–7, female, 2; ovipositor, 30–32. Width, pronotum across metazona, male, 6, female, 8.

Type.—Apparently lost.

Specimens examined.—Two pairs in the Scudder collection from Fort Reading, Shasta Valley, California, taken by Lieut. Williamson.

This species was described by Thomas from a female taken by Henshaw at San Carlos, Arizona. I have been unable to find this specimen in any of the collections studied. The specimens in Scudder's collection are moldy and much worn and probably very poorly represent the coloration of living specimens.

This large bulky insect is conspicuously distinct from the other members of the genus. The cerci of the males of this and the following three species are in some respects similar and are very different from the types represented by the preceding species. The last dorsal segment of the abdomen also differs materially from those of the preceding forms.

IDIOSTATUS HERMANII Thomas.

Steiroxys hermanii Thomas, Rept. U. S. Geol. Surv. W. 100 Mer., V, 1875, p. 904, pl. xliv, fig. 4.—Proc. Davenp. Acad. Nat. Sci., I, 1876, p. 263.

Idiostatus hermanii Scudder, Can. Ent., XXVI, 1894, pp. 181, 183; Cat. Orth. U. S., 1900, p. 78.—Woodworth, Bull. No. 142, Calif. Exp. Stat., 1902, p. 15.—Kirby, Syn. Cat. Orth., II, 1906, p. 193.

Idiostatus californicus Pictet, Mem. Soc. Phys. Hist. Nat. Genev., XXX (6), 1888, p. 64, pl. iii, figs. 35, 35 *a*, *b*.

Description.—In general characters allied to *I. bilineatus*, but is a much smaller and more slender insect. The head and thorax, also the abdomen and elytra, are essentially as in *æqualis*. The lateral carinæ of the pronotum are moderately distinct, less so anteriorly. The posterior femora are less than three times as long as the pronotum, armed on both margins below, and the anterior tibiæ are armed above on the outer side only with three spines. The elytra of the male extend beyond the posterior margin of the pronotum, a distance less than the thoracic length, the outer apical angle immaculate; of the female extending only a couple of millimeters beyond the pronotum. Genitalia similar to that of *bilineatus*, the cerci of the male, however, a little more concave between the apex and the tooth.

Color brownish yellow, the base of the last abdominal segment sometimes marked at the upper portion of the sides with black, and the lateral lobes of the pronotum are usually more or less distinctly margined with lighter color. Otherwise, the color is quite uniform in all cabinet specimens examined. In life the insects are often grass green, but, as represented by a series of over a dozen immature specimens taken by me on July 24, 1906, on a species of *Ceanothus*, a small holly-like plant forming dense mats on the ground at the base of Mount Shasta, California, the colors are often of various hues, the general color sometimes bright chocolate brownish or sometimes red. The lateral lobes of some of these immature specimens were black, but in most cases they are brownish.

Measurements.—Length, pronotum, male, 6.5–8 mm., female, 8; posterior femora, male, 17–22, female, 23; elytra, male, 5, female, 2; ovipositor, 26.

Specimens examined.—A number of specimens from the Mount Shasta district in California.

The type of *californicus* is probably in the collection of Brunner von Wattenwyl, but that of *hermanii* seems to be lost, not having been found in any of the collections studied by me. The Scudder collection contains one male specimen from Mount Shasta District, California, labeled *I. californicus*, by Scudder. Besides the specimens taken by the writer at Mount Shasta, California, in July, 1906, as mentioned above, the National Museum contains an adult pair from the same locality taken in September, 1885, by Behrens. They were presented

to the Museum by Bruner. Besides the above-mentioned specimens, the National Museum has a single female specimen without locality, also presented by Bruner, that is referred here with some doubt. It is somewhat smaller than the adult from Shasta, and the sides of the abdomen are marked with black on the posterior margins, and the last two segments are wholly black laterally. The abdomen has also a pair of pale narrow subdorsal stripes. The anterior tibiæ are spined above on both margins. The posterior femora are missing.

IDIOSTATUS FUSCOPUNCTATUS Scudder.

Cacopteris fuscopunctata Scudder, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 88, 89; Cat. Orth. U. S., 1900, p. 78.—Woodworth, Bull. No. 142, Calif. Exp. Stat., 1902, p. 15.—Kirby, Syn. Cat. Orth., II, 1906, p. 194.

Cacopteris punctata (error for *fuscopunctata*) Caudell, Proc. U. S. Nat. Mus., XXVIII, 1905, p. 477.

Description.—Male, female unknown. Head and pronotum as in *æqualis*, the lateral lobes of the latter scarcely sinuate behind. Elytra extending beyond the pronotum a distance equal to about one-half the length of the pronotum, the outer apical angles marked by a black spot. Legs moderately long, the posterior femora about three times as long as the pronotum, armed below with a few small black spinules on both margins; anterior tibiæ armed above on the outer margin only with three spines. Cerci similar to those of *I. hermanii* (fig. 67). The last abdominal segment of the male (fig. 68) is very different from that of *hermanii*, the apical lobes being triangular, sharply pointed, not extending back to the tip of the subgenital plate and separated by a deep rounded incision, in this respect somewhat allied to *I. æqualis*.

67

68

Figs. 67, 68.—Idiostatus fuscopunctatus. 67, cercus of male. 68, last dorsal abdominal segment of male.

Measurements.—Length, pronotum, 4.5 mm.; posterior femora, 14; elytra, 2.5.

Type.—In the Scudder collection.

Specimens examined.—The type, a single male from Tehachapi, California, taken by Morse on August 2, and a single immature male specimen in the National Museum taken by Oslar at Nogales, Arizona, on July 13, 1903.

IDIOSTATUS REHNI, new species.

Description.—Head moderate, scarcely prominent; vertex broad and moderately prominent, one-third, or a little more than one-third, as broad as the interocular space. Eyes rounded, of moderate size and prominence. Antennal scrobes about one-half as large as the vertex as viewed from in front. Pronotum moderately large and considerably produced posteriorly; lateral lobes well developed,

nearly as deep as long, slightly declivent and considerably sinuate posteriorly; lateral carinæ of the female very dull but nearly persistent, converging somewhat about the middle of the anterior third, at which point the disk is cut by a distinct but narrow transverse sulcus, in the male the lateral carinæ are scarcely indicated anterior of the posterior half of the pronotum and are almost parallel, the disk in this sex with the transverse sulcus scarcely noticable, forming a mere line; median carina inconspicuously present only on the posterior third of the pronotum in both sexes; disk almost flat for the entire length in the female, in the male slightly flattened on the posterior half or a little less, the anterior portion broadly rounded; anterior and posterior margins subtruncate in both sexes. Legs moderately long, the posterior femora three times, or almost three times, as long as the pronotum, parallel in the apical half, the basal half much and abruptly ampliate and armed below on both margins with several short, sharp, black spinules; anterior tibiæ armed above on the outer

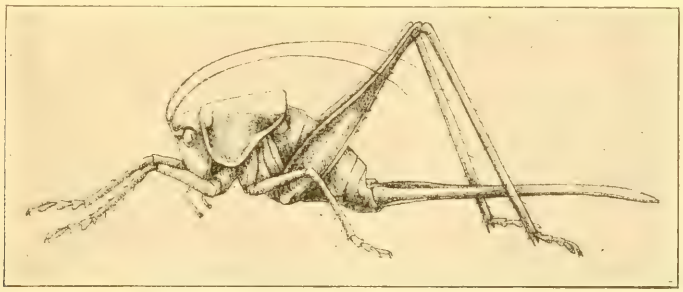


Fig. 69.—Idiostatus rehni. Adult female.

margin only with three spines, rarely with four. Elytra of the male extending beyond the pronotum a distance equal to about one-half the length of the pronotum, uniform in color; in the female the elytra are mere lateral pads scarcely extending beyond the pronotum. Abdomen moderately plump, subcarinate, the last dorsal segment in the male broadly and roundly concave and flattened apically as in *hermanii*; cerci of the female about four times as long as the basal breadth, cylindrical and tapering nearly uniformly to an acute point, of the male cylindrical at the base, somewhat depressed apically and acutely pointed, furnished on the inner side with a triangular tooth as long as the cercal width at that point, the lower margin of the tooth perpendicular to the main body of the cercus and situated about the middle of it (fig. 70). Ovipositor considerably longer than the posterior femora and curved slightly downward (fig. 69), apically pointed, the tip granulose.

Color uniformly reddish or yellowish brown, in life probably usually green. The lateral lobes of the pronotum in living specimens are prob-

ably margined below and posteriorly with light yellow. The elytra of the males are uniformly yellowish brown, the membrane and veins unicolorous, the outer apical margins not marked by a black spot. The spines of the legs are tipped with black and the spinules on the underside of the posterior femora are black to the base.

FIG. 70.—IDIOSTATUS REHNI. CERCUS OF MALE.

Measurements.—Length, pronotum, male, 6.5 mm., female, 8; posterior femora, male, 18–19, female, 24; elytra, male, 3.5–4.5, female, about .5; ovipositor, 29.

Type.—Cat. No. 10184, U. S. National Museum.

Specimens examined.—Two males, one female, Siskiyou County, California (A. Koebele).

Superficially the males of this species resemble very much some yellowish males of *Eremopedes ephippiata*, but the cerci and superaanal plate are very different. I have named this species in honor of Mr. J. A. G. Rehn, of Philadelphia, Pennsylvania.

IDIOSTATUS ELEGANS, new species.

Description.—Head large, slightly broader than the anterior portion of the pronotum, into which it is moderately inserted; fastigium somewhat prominent, about as broad as one of the eyes, one-third as broad as the interocular space; front broadly rounded; eyes moderate in size, scarcely prominent, slightly elongate. Pronotum large, posteriorly produced over the base of the abdomen; lateral lobes well developed, nearly as deep as long and slightly sinuous posteriorly; lateral carinæ indicated only posteriorly and there very broadly rounded; median

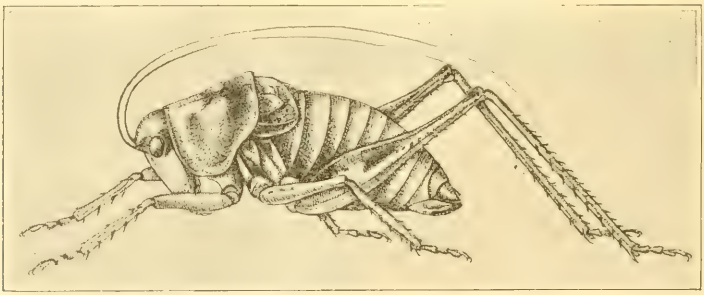


FIG. 71.—IDIOSTATUS ELEGANS. ADULT MALE.

carina very slight, subpersistent in both sexes, but very slender and obscure, especially in the female; disk broadly rounded, subtruncate anteriorly and posteriorly, anteriorly sometimes a little emarginate, cut across the anterior fifth by a slender transverse sulcus and mesially marked by a broader V-shaped sulcus, not extending to the sides. Prosternum unarmed. Legs short and stout; posterior femora about two

and one-half times as long as the pronotum, much swollen on the basal two-thirds and armed beneath with several very short, triangular, black spines; anterior tibiæ armed above on the outer side only with three spines. Elytra in the male overlapping above and extending beyond the pronotum a distance a little less than one-half the length of the pronotum, of the female broad, almost touching above and projecting beyond the pronotum a distance equal to about one-fourth the pronotal length. Abdomen plump, scarcely carinate; last abdominal segment apically depressed and mesially roundly incised; cerci of the male thick and broad, apically roundly tapering to a point and armed on the inner side with a sharp spine (fig. 72); cerci of the female short and stout, about two and one-half times as long as the basal breadth and rapidly tapering to a point. Ovipositor longer than the posterior femora and nearly straight, apically very slightly upcurved.

FIG. 72.—IDIOSTATUS ELEGANS. CERCUS AND LAST DORSAL ABDOMINAL SEGMENT OF MALE.

Color reddish brown, in the male lighter, marked with black. The head has a broad black postocular stripe and a black streak on the top. Pronotum mesially marked with a triangular black spot and behind with a submarginal broad black transverse stripe extending halfway down the side of the latéral lobes, more conspicuous in the male. Elytra yellow with paler veins. Abdomen with the last two segments shiny black, except the mesial emargination of the terminal one. Ovipositor black, yellowish apically and below basally. Posterior femora marked with black above at the base, on the outer face mesially and at the tip. The spines of the femora and the posterior tibiæ are black, and both femora and tibiæ of all the legs are black at the base of the spines.

Measurements.—Length, pronotum, male, 9 mm., female, 9.5; posterior femora, male, 22, female, 24; elytra, male, 4.5, female, 3; ovipositor, 26; width, pronotum across metazona, male, 6.5, female, 7; posterior femora at the narrowest point, male, 1.5, female, 1.5; at the widest point, male, 5.25, female, 5.5; ovipositor in the middle, 2.

Types.—Cat. No. 10185, U. S. National Museum.

Specimens examined.—The types, one male (fig. 71), one female, Nevada (E. H. Hillman).

This robust and prettily marked species, which was secured from the collection of Bruner, reminds one somewhat of an *Anabrus*, but it is not related to that genus.

IDIOSTATUS INERMIS Scudder.

Cacopteris inermis SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 88, 89; Cat. Orth. U. S., 1900, p. 78.—BAKER, Invert. Pacifica, I, 1903, p. 14.—KIRBY, Syn. Cat. Orth., II, 1906, p. 194.

Cacopteris nevadensis SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 91, 92, female, not male.

Description.—Lateral lobes of the pronotum well developed, almost as deep as long and scarcely at all sinuate posteriorly. Tegmina of the male unicolorous, the outer apical angles not marked by a black spot, extending beyond the pronotum a distance equal to more than one-half the pronotal length. Legs moderately short, the posterior femora less than, or a little more than, three times as long as the pronotum; anterior tibiæ armed above on the outer side only with three spines, very rarely the inner margin bears one spine. Cerci of the female about four times as long as the basal width, much swollen basally and tapering rapidly on the base of the apical half, the terminal portion tapering gradually to a point; in the male the cerci are very different from those of any other known species, the base being considerably compressed and the apical portion forms two sharp depressed incurved teeth, the upper one short and the lower one twice as long, both directed at right angles or less to the main body of the cercus and the tips still more incurved and black, that of the upper tooth merely sharp pointed, but that of the lower one very slender and sharp; this longer lower tooth is more than one-half as long as the main body of the cercus and the slender pointed apical portion is half as long as the body of the tooth itself (fig. 73). Last abdominal segment of the male with the apical lobes broad, short, and rounded, the intervening sinus broad and arcuate. Ovipositor almost as long or considerably longer than the posterior femora and straight.

FIG. 73.—IDIOSTATUS INERMIS. CERCUS OF MALE.

Color dark brownish, the dorsum sometimes wholly testaceous and sometimes colored as the rest of the body. Pronotum with the lateral lobes usually margined below and posteriorly with luteous. Tegmina of the male fusco-testaceous, unicolorous. Legs fusco-testaceous.

Measurements. Length, pronotum, male, 5–5.75 mm., female, 5–5.5; posterior femora, male, 14–17, female, 17–18.5; elytra, male, 3.5–4, female, 1–1.5; ovipositor, 18–20.

Types. In the Scudder collection and in that of Professor Morse.

Specimens examined.—I have examined the types from Nevada in the collections of Scudder and Morse and an adult pair from Nevada in the latter collection taken by Baker, and a single adult male in the National Museum collection from Reno, Nevada, presented by Professor Bruner,

The female described by Scudder as that of *I. nevadensis* is really that of *inermis*, the only difference between that specimen and the female types of *inermis* being the slightly longer posterior femora and different color. But the specimens, male and female, taken by Baker in Nevada, serve to prove these features variational.

IDIOSTATUS FEMORATA Scudder.

Cucopteris femorata SCUDDER, Proc. Amer. Acad. Arts Sci., XXXV, 1899, pp. 88, 93; Cat. Orth. U. S., 1900, p. 78.—WOODWORTH, Bull. No. 142, Calif. Exp. Stat., 1902, p. 15.—KIRBY, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Female, male unknown—Pronotum with the lateral lobes well developed and slightly sinuate posteriorly; lateral carinæ indicated only on the posterior portion of the pronotum, where they are quite distinct. Legs unusually long, the posterior femora more than four times as long as the pronotum; anterior tibiæ armed above on both margins, three spines on the outer margin, two on the inner. Cerci about as in the female of *I. inermis* but less attenuate apically. Ovipositor considerably shorter than the posterior femora and feebly curved upwards.

Color uniformly dark fusco-testaceous, the posterior femora lighter with darker stripes on the outer and inner faces.

Measurements.—Length, pronotum, 5.75 mm.; posterior femora, 25; elytra, 1; ovipositor, 18.5.

Type.—In the Scudder collection.

Specimens examined.—The unique type, a female from South Santa Monica, California (J. J. Rivers), is the only specimen of this species seen. It was taken on July 30.

IDIOSTATUS VARIEGATA, new species.

Description.—Female; male unknown. Head about as wide as the anterior part of the pronotum into which it is moderately inserted; vertex prominent and nearly one-half as broad as the interocular space; eyes medium in size, not prominent, rounded, narrowing slightly below; basal segment of the antenna no more than one-half as broad as one of the eyes. Pronotum medium in size and well produced posteriorly; lateral lobes well developed but not as deep as long, moderately declivent, and slightly sinuate posteriorly; lateral carinæ not at all indicated anteriorly, posteriorly scarcely so, being no more than well-rounded shoulders; median carina not present; disk transversely rounded, without transverse sulci, but marked on the middle by a U-shaped depression; anterior and posterior margins truncate, the former mesially a little concave. Prosternum unarmed. Legs stout, the posterior femora three times as long as the pronotum, much swollen on the basal two-thirds, and armed below on each side

with a few minute stout black spines, usually scarcely more than acute tubercles; anterior tibiæ armed above on the outer side only with three spines; anterior femora with two or three very small short spines below on the inner margin. Elytra lateral and projecting a little beyond the pronotum. Abdomen moderately stout, scarcely carinate dorsally; cerci about three times as long as the basal breadth, round, and rapidly tapering; ovipositor almost straight, just perceptible, curved upward in the apical half, considerably shorter than the posterior femora.

Color yellowish, with the upper portions of the lateral lobes of the pronotum and the abdomen, except the posterior margins of each segment and a pair of subdorsal stripes, fuscous. The disk of the pronotum is marked by a spear-shaped fuscous spot.

Measurements.—Length, pronotum, 7.25 mm.; posterior femora, 22.5; elytra, 1.5; ovipositor, 18; width, pronotum across metazona, 4.5; posterior femora at narrowest point, 1.25, at widest point, 4.5; ovipositor, at the middle, 1.5.

Type.—Cat. No. 10186, U. S. National Museum.

Specimen examined.—One female, Pocatello, Idaho. Presented by Professor Bruner.

PLAGIOSTIRA Scudder.

Plagiostira SCUDDER, Ann. Rept. Chief Eng., 1876, p. 501; Can. Ent., XXVI, 1894, pp. 179, 182; Guide Orth. N. Amer., 1897, p. 57.—KIRBY, Syn. Cat. Orth., II, 1906, p. 195.

Description. Head small, not prominent, very deeply inserted into the pronotum; vertex very narrow, less than one-fourth as broad as the interocular space and scarcely prominent; eyes rounded, of medium size and very prominent. Thorax large, posteriorly much produced; lateral lobes very shallow, not sinuate posteriorly, perfectly vertical; lateral carinæ well developed except on the anterior fifth, where they are very obscure and rounded, straight or bowed out considerably in the middle; median carina distinct, but dull, on the posterior border only, sometimes scarcely indicated, in some specimens anteriorly replaced by a double sulcus; disk flat, rectangular or somewhat oval in form, with a broad, deep transverse sulcus occupying the middle part of the posterior half; this broad depression does not, however, interrupt the lateral carinæ; across the middle of the anterior third is a narrow but distinct and moderately deep transverse furrow or sulcus, in front of which the lateral carinæ are but poorly developed, the sulcus passing down across the lateral lobes to near the lower margin. The anterior margin of the pronotal disk is truncate, the posterior margin broadly rounded. Prosternum unarmed but sometimes furnished with a pair of very small tubercles where spines are usually situated; the mesosternal lobes are angularly developed in the sem-

blance of stout spines. Elytra, except in *gillettei*, where they are abortive, the only known specimen probably immature, overlapping above in both sexes and projecting beyond the pronotum about half its length in the male; somewhat less in the female; wings are about the same size as the elytra and coal black. Legs stout and moderately long, the posterior femora less than two times as long as the pronotum or considerably more, or much more, than two times as long, moderately or little swollen in the basal half and unarmed beneath or armed on both carinæ with a few very small blunt spinules; anterior tibiæ armed above on the outer side only with three or four spines, rarely with but two. Abdomen moderately heavy; supraanal plate elongate triangular, partially hidden beneath the last abdominal segment, which, in the male, extends backward as two projections, triangular, about as long as the basal width, the intervening sinus V-shaped; last abdominal segment of the female simple but more depressed and shorter than that of the male; subgenital plate of both sexes apically forked, the incision V-shaped, the terminal styles in the male very short and stout, subtriangular or cylindrical and more elongate. Cerci short, scarcely attaining the apex of the subgenital plate in the male (fig. 75), cylindrical in both sexes, in the female simple, conical; in the male tapering, bluntly rounded at the apex and furnished on the inner side with two short, round, blunt teeth, one just before the apex and one just beyond the middle. Ovipositor considerably longer than the posterior femora and distinctly curved downward.

Type.—Plagiostira albonotata Scudder.

The members of this genus may be separated as follows:

KEY TO THE SPECIES OF PLAGIOSTIRA.

A. Pronotal disk distinctly more than one and one-half times as long as its greatest width, the lateral carinæ parallel or scarcely perceptibly bowed outward, the disk rectangular. Organs of flight projecting well beyond the pronotum.

B. Posterior femora more than two times as long as the pronotum, *albonotata*, p. 389.

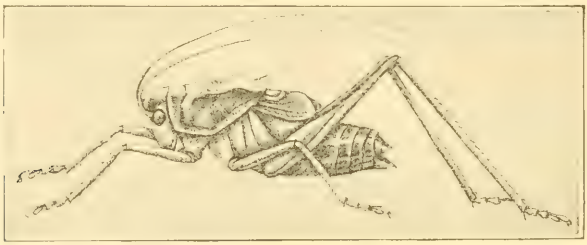
B′. Posterior femora less than two times as long as the pronotum, *albonotata* var. *brevipes*, p. 392.

A′. Pronotal disk no more than one and one-half times as long as the greatest width, the lateral carinæ distinctly bowed outward in the middle, the disk subovate. Organs of flight not projecting beyond the pronotum, at least in the only specimen seen ..... *gillettei*, p. 392.

PLAGIOSTIRA ALBONOTATA Scudder.

Plagiostira albonotata SCUDDER, Ann. Rept. Chief Eng., 1876, p. 501 (1876); Ann. Rept. U. S. Geol. Surv. W. 100 Mer., 1876, p. 281; Can. Ent., XXVI, 1904, p. 182; Cat. Orth. U. S., 1900, p. 79—SCUDDER and COCKERELL, Proc. Davenp. Acad. Nat. Sci., IX, 1902, p. 55—CAUDELL, Proc. U. S. Nat. Mus., XXVI, 1903, p. 807.—KIRBY, Syn. Cat. Orth., II, 1906, p. 195.

Description.—Head moderate, about as broad as the anterior portion of the pronotum, into which it is inserted quite deeply; vertex very narrow, barely one-fifth as broad as the interocular space and moderately prominent, longitudinally narrowly sulcate; eyes large and very prominent, semiglobular; basal segment of the antenna considerably larger than the vertex as viewed from the front. Pronotum long and moderately narrow, more than one and one-half times as long as the greatest width; lateral lobes shallow, no more than one-half as deep as long, vertical, not sinuate posteriorly; lateral carinæ sharp to the anterior transverse sulcus, thence continuing as barely discernible rounded angles, parallel or subparallel; median carina practically absent or obscurely present on the hind border posterior of the median transverse sulcus; disk flat, cut across the middle by a broad shallow sulcus as described under the genus, and across the middle of



74

75

76

FIGS. 74, 75, 76.—PLAGIOSTIRA ALBONOTATA. 74, ADULT MALE. 75, CERCUS OF MALE. 76, VAR. BREVIPES, OVIPOSITOR.

the anterior third by a conspicuous transverse sulcus, which extends down across the lateral lobes nearly to the lower border; anterior margin truncate, posterior margin broadly rounded. Prosternum unarmed; mesosternal lobes acutely prolonged. Legs variable, the posterior femoræ decidedly less than twice as long as the pronotum (fig. 74) to two and one-half times as long, armed below on one or both margins with a few very minute spinules, or usually unarmed, parallel on the apical half or nearly so, the basal half very moderately swollen, no more than two times as thick as the apical portion; anterior tibiæ armed above on the outer side only, with three or four spines. Wing covers about two times as long as broad, meeting above, usually overlapping, and extending beyond the pronotum in both sexes, a distance equaling one-half the length of the pronotum in the male, sometimes less in the female, the tympanum of the male occupying about one-

half the length of the projecting portion of the elytra; wings about as long as the elytra. Genital characters as described under the genus, the ovipositor (fig. 76) curved distinctly downward and considerably longer than the posterior femora.

Color yellowish brown, in dried specimens usually quite uniform, except the wings, which are piceous, conspicuously contrasting with the brownish colored elytra, which are finely reticulate with lighter veins in both sexes. In some specimens, however, there are conspicuous chalky white markings, a transverse, faint white stripe following the lower portion of the genæ, another, broader and more conspicuous, starting below the eye and passing back along the lower margin of the lateral lobe of the pronotum. In these conspicuously marked specimens another white line runs from the upper portion of the eye to the anterior transverse sulcus of the pronotal disk, and the disk and lateral lobes bear a number of spots and dashes of white and each abdominal segment has an anteriorly directed triangular subdorsal and lateral spot, which, together, form subcontinuous subdorsal and lateral lines extending the entire length of the abdomen.

Measurements.—Length, pronotum, male, 7.5–9.5 mm., female, 8–10; posterior femora, male, 15–18, female, 16–22.5; elytra beyond the pronotum, male, 4–5, female, 2–5; ovipositor, 22–31; width, pronotum at the middle, male, 4.5–5, female, 4.75–6.5.

Type.—In the Scudder collection at Cambridge, Massachusetts.

Of this species I have recognized a variety which is separated from the typical form in the above table of species.

The typical form has the posterior femora two times or more than two times as long as the pronotum. The color of both varieties probably exhibit about the same range of variation. The measurements of this typical form are as follows:

Measurements.—Length, pronotum, male, 7.5–9 mm., female, 8–10; posterior femora, male, 15–18, female, 17.5–22.5; elytra, beyond the pronotum, male, 4–5, female, 2–4; ovipositor, 23–31; width, pronotum, male, 4.5–5, female, 4.75–6.5.

Specimens examined.—Besides the type, a single female from New Mexico, in the Scudder collection, I have studied one male, two females, Durango, Colorado, August 3, one male, Dolores, Colorado, August 2 (Gillette); one immature female, Pindale, Arizona (W. Hough), one female, Morrison, Colorado, and one female, Albuquerque, New Mexico (Cockerell).

The male specimen from Dolores, Colorado, is very small, the thoracic width being 4.5 mm. and the length of the posterior femora being but 15 mm. The female from Albuquerque, New Mexico, which is in the Scudder collection, is unusually large, the measure-

ments being as follows: Length, pronotum, 9 mm., posterior femora, 22.5, ovipositor, 31; width, pronotum, 6.5.

The very long posterior femora and ovipositor of this specimen give it a very distinctive appearance. The ovipositor is slightly more strongly curved downward apically and the pronotum is broader than usual. I refrain from giving it at least a varietal name only because of the unusual range of variation of size among the specimens of the species studied. Except in pronotal length it represents the maximum measurements made, aside from it the largest measurements made of female specimens being as follows:

Length, pronotum, 8.75–9.5 mm.; posterior femora, 21.5; ovipositor, 28; width, pronotum, 5.5.

The male of this species has never been described, though the male of the following variety has been recorded but not described.

PLAGIOSTIRA ALBONOTATA var. BREVIPES, new variety.

Description.—This variety is characterized by the short posterior femora. It is of a more robust form than the typical variety. The wings of the two specimens examined are thrust out at right angles to the elytra, their coal-black color very conspicuous against the yellowish brown background. The measurements are as follows:

Measurements.—Length, pronotum, male 8.5 mm., female 9; posterior femora, male 15, female 16; elytra, beyond the pronotum, male 4, female 3; ovipositor, 22; width, pronotum, male and female, 5.

Type.—Cat. No. 10187, U. S. National Museum.

Specimens examined.—One male, one female, Williams, Arizona, July 24, 1901, collected on sagebrush by H. Barber.

The above are the specimens recorded by me[a] some time ago as *P. albonotata*. This variety may eventually prove to be worthy of specific distinction, but in view of the extraordinary range of size of the specimens of the genius studied it is thought better to give it only varietal rank at this time.

PLAGIOSTIRA GILLETTEI, new species.

Description.—Male; female unknown. Head scarcely as broad as the anterior portion of the pronotum, into which it is deeply inserted; vertex scarcely raised out of the general contour of the head very narrow and not at all prominent; the eyes are moderately large and very prominent; basal segment of the antenna fully as large as the vertex as viewed from in front. Pronotum unusually large, distinctly broader in the middle than at either end; lateral carinæ bowed very noticeably outward, giving the pronotal disk somewhat the appearance of that of the members of the genus *Aglaothorax* (fig. 77), except it is flat

[a] Proc. U. S. Nat. Mus., XXVI, 1903, p. 897.

and roughened by rugosities and convolutions, the median transverse furrow broad; the anterior margin of the disk is truncate and the posterior margin is semicircularly rounded; median carina distinct only behind the broad transverse furrow, anteriorly replaced by a faint double longitudinal sulcus; lateral lobes longitudinally concave with a few tortuous sulci breaking the otherwise smooth surface. Organs of flight wholly concealed beneath the pronotum, the wings, like those of the typical species, coal black. Posterior femora considerably less than two times as long as the pronotum and not greatly swollen basally, the greatest width near the base no more than twice that of the narrowest part in the apical half, the swelling confined to the basal half; all the femora are armed beneath on both sides with a few very inconspicuous short, stout spinules, anterior tibiæ armed above on the outer side only with three spines. Genital organs as described under the genus.

FIG. 77.—PLAGIOSTIRA GILLETTEI, MALE.

Color, yellowish, with the disk of the pronotum with fuscous mottlings, the center of the broad sulcus showing a green cast and a short longitudinal black stripe in the center of the pronotum next the anterior border, posteriorly terminating at the anterior narrow transverse sulcus. The wing pads are piceous and the abdominal segments have each a row of round black spots along the posterior margin.

Measurements.—Length, pronotum, 11.5 mm.; posterior femora, 18.5; width of pronotum across widest part, 7.5.

Type.—Cat. No. 10188, U. S. National Museum.

Specimen examined.—One male, Grand Junction, Colorado, June 20, 1905. Collected by C. P. Gillette, who presented the interesting insect to the National Museum and in whose honor I take pleasure in naming it.

This is a characteristic-appearing insect. It may be somewhat immature as suggested by the smaller wings, the outer pair of which is twisted beneath the under ones and their development propably incomplete.

IDIONOTUS Scudder.

Idionotus SCUDDER, Can. Ent., XXVI, 1894, pp. 179, 182 (invalid, no species included); Guide N. A. Orth., 1897, p. 56 (invalid, no species included); Cat. Orth., U. S., 1900, p. 79.

Description.—Head medium in size; vertex moderately or scarcely at all prominent, broad more than one-third as broad as the interocular space; eyes small, usually somewhat prominent. Pronotum medium, not greatly produced posteriorly; lateral lobes well developed, nearly as deep as long, considerably declivent and moderately sinuate posteriorly; lateral carinæ sharp, except in *subcarinata*, persistent and strongly or moderately convergent at the middle of the anterior half; median carina absent or barely indicated on the posterior third of the pronotum; disk nearly flat, marked about the middle by an inconspicuous U-shaped sulcus or a transverse sulcus, truncate before and behind or broadly rounded posteriorly. Prosternum unarmed. Legs long, the posterior femora more than two times as long as the pronotum, subparallel on the apical two-fifths, the basal portion considerably swollen, unarmed beneath or armed on both margins with a few short spines; anterior tibiæ armed above on the outer side only with three spines, rarely but two. Elytra nearly touching above and slightly projecting beyond the pronotum in the female, except in *subcarinatus*, where they are concealed; in the male, where known, the elytra overlap above and project beyond the pronotum a distance equal to one-half the length of the pronotum or more. Subgenital plate of both sexes apically notched, the apical styles of the male stout, fusiform; last abdominal segment triangular and entire in the female, in the male triangularly incised apically; cerci simple in the female, in the male armed at the extreme base with an inner spine and sometimes with a short apical spine.[a] Ovipositor short and stout, no longer than the posterior femora, abruptly tapering to a sharp point.

Type.—*Idionotus brunneus* Scudder.

The median dorsal spine of the anterior tibiæ is sometimes missing, but the normal number seems to be three.

Kirby[b] places this genus in the synonymy under the genus *Neduba* of Walker. In this he is certainly in error, the type of *Neduba* being the same as that of *Tropizaspis*.

We have three species of this genus, separable as follows:

KEY TO THE SPECIES OF IDIONOTUS.

A. Lateral carinæ of the pronotum sharp, distinct.

B. Posterior femora three or more times as long as the pronotum; cerci of the male no longer than broad and armed on the outer apical extremity with a sharp point, fig. 79½ ..... *brunneus*, p. 395

[a] This basal spine is not easily observed unless the cerci are unusually exerted.

[b] Syn. Cat. Orth., II, 1906, p. 194.

B′. Posterior femora no more than two and one-half times as long as the pronotum; cerci of the male twice as long as broad and apically unarmed, fig. 80.
brevipes, p. 396

A′. Lateral carinæ of the pronotum dull, somewhat indistinct.
subcarinatus, p. 397

IDIONOTUS BRUNNEUS Scudder.

Idionotus brunneus Scudder, Cat. Orth., U. S., 1900, p. 98.—Woodworth, Bull. No. 142, Calif. Exp. Stat., 1902, p. 15.
Neduba brunneus Kirby, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Head scarcely as broad as the anterior portion of the pronotum, into which it is moderately deeply inserted; vertex broad, convex, not sulcate, one-third or more than one-third as broad as the interocular space and quite prominent; eyes rounded, moderately large and quite prominent; basal segment of the antennæ not quite as large as the vertex as viewed from in front. Pronotum very moderately produced posteriorly, the lateral lobes nearly as deep as long and declivent; lateral carinæ converging on the anterior fourth to two-thirds the distance that separates them posteriorly (fig. 79); pronotal disk rounded truncate behind and in front, marked with an obscure U-shaped sulcus near the middle. Elytra of female apically broadly rounded, nearly meeting above and projecting but little beyond the pronotum; of the male overlapping above and projecting beyond the pronotum a distance equal to about one-half the length of the pronotum. Legs long, the posterior femora more than three times as long as the pronotum and armed below on both margins with some small spines. Genitalia of female as described under the genus; the cerci of the male no longer than broad and, in addition to the short basal spine, is armed with an acute apical point (fig. 80).

78

79

80

FIGS. 78, 79, 80.—IDIONOTUS BRUNNEUS. 78, ADULT FEMALE. 79, PRONOTUM OF FEMALE FROM ABOVE. 80, CERCUS OF ADULT MALE.

Color uniformly brown, the face a little paler and the ovipositor a little more reddish brown. The pronotum of the male is sometimes briefly blackish on the extreme posterior portion, next the lateral carina.

Measurements.—Length, pronotum, male, 6 mm., female, 5.25; elytra, beyond the pronotum, male, 2.5–3, female, 1.5; posterior femora,

male, 20, female, 19.5; ovipositor, 15; width, pronotum at narrowest point, male 3, female, 2.25; posteriorly, male, 4, female, 3.5.

Type.—Cat. No. 5733, U. S. National Museum.

Specimens examined.—One female, the type (fig. 78), Folsom, California, July 7, 1885 (Koebeli), and three males, Thrall, California (Caudell).

In his original description Doctor Scudder gives the length of the pronotum as 6 mm., but I can make it no more than 5.25.

Besides the female type the National Museum contains three males taken by the writer at Thrall, California, July 28, 1906. They were taken in the evening singing in clumps of small oak shrubs. They sit a few inches above the ground and stridulate very persistently, not ceasing even when approached very closely. With a little care an observer can easily approach and study the insect songster from a distance of but a few inches. It requires a keen sight to locate the insect at first, as it is protectively colored, blending so nicely with its surroundings as to be practically invisible. When disturbed they leap to the ground among the dead leaves and such débris as usually gathers under the bushes and disappear. The note is a very low and soft, but quite high-keyed, thrill, repeated rapidly for long periods at a rate of about one hundred and fifty distinct notes per minute. Each note is made by one rasp of the short elytra.

IDIONOTUS BREVIPES, new species.

Description (Male; female unknown).—Head of moderate size, not swollen, inserted moderately into the pronotum; vertex not prominent, rounded, broad, decidedly broader than one of the eyes, which are of medium size and not prominent; antennæ slender. Pronotum of medium size, posteriorly produced well over the wings; lateral lobes deep, two-thirds as deep as long and nearly vertical, flaring a little below, posteriorly scarcely sinuate; lateral carinæ well developed, somewhat acute, nearly straight, approaching on the anterior half to one-half their posterior distance apart, and then, just before reaching the anterior edge of the pronotum, they expand slightly. Pronotal disk flat, divided about the middle by a very broad and rather deep transverse sulcus or depression; median carina present only posterior of this transverse depression, where it is rather distinct and well developed, anterior margin of the disk truncate, posterior margin broadly rounded. Wings aborted, elytra fully as long as the pronotum and very broad, overlapping more than usual in this group apically, near the costa, with a notch. Abdomen moderately slender, hardly carinate; cerci (fig. 81) cone shaped armed near the base on the inner side with a sharp black spine directed inwards and with the apical half bent upwards with a sharp curve, the whole cerci no more than twice

FIG. 81.—IDIONOTUS BREVIPES. CERCUS OF MATURE MALE.

as long as the basal width and not extending outside of the cavity formed by the subgenital plate and the last abdominal segment, the basal spine noticeable only when the cerci are removed or pushed laterally far back; subgenital plate long and triangularly incised and bears a pair of movable, club-like apical styles, two times as long as broad. Legs short, posterior femora less than two and one-half times as long as the pronotum, parallel on the apical two-fifths, unarmed; coxal spines of the anterior legs broad and sharp; anterior tibiæ armed on the outer side above with three spines, unarmed on the inner side. Posterior tibiæ with the plantulæ very poorly developed.

Color light yellowish brown; lateral lobes of the pronotum infuscated quite uniformly and heavily on the disk, the lower margin, the posterior third, and a narrow margin along the anterior edge being light yellowish. There is a row of black spots down each side of the abdomen and the outer face of the posterior femora is striately infuscated.

Measurements.—Length, pronotum, 5.5 mm.; elytra, beyond the pronotum, 6; posterior femora, 12; cerci, 1.5.

Type.—In the Scudder collection.

Specimens examined.—One male, Arctic America (Kennicott). This species was mentioned, but not described, by Doctor Scudder.[a] It is certainly a new species, as shown by the short posterior femora and other less obvious points of difference.

IDIONOTUS SUBCARINATUS, new species.

Description.—Female, male unknown. Head medium, scarcely broader than the anterior portion of the pronotum; fastigium somewhat prominent, a little broader than the basal segment of the antenna, about one-third as broad as the interocular space; eyes scarcely prominent, nearly round, very slightly flattened anteriorly; antennæ, except the basal segment, very slender. Pronotum moderately large and posteriorly produced over the base of the abdomen so as to completely conceal the organs of flight; lateral lobes well developed, declivate, posteriorly broadly sinuate; lateral carinæ dull, but distinct, made more distinct by the coloration, persistent, considerably bowed inwards in the anterior half, the posterior portion of the disk being a third broader than the narrowest portion; median carina not indicated; pronotal disk broadly convex, truncate anteriorly and posteriorly, without transverse carinæ, marked in the center with a broad obscure transverse depression. Prosternum unarmed. Organs of flight wholly concealed beneath the pronotum. Legs moderately stout, the posterior femora three times as long as the pronotum and much swollen on the basal two-thirds; all the femora unarmed; anterior tibiæ armed above on the outer side only with three spines, below on both sides; pos-

[a] Canadian Entomologist, XXVI, 1894, p. 282.

terior and intermediate tibiæ armed on both margins, both above and below. Cerci conical, simple, about three times as long as the basal breadth. Ovipositor nearly as long as the posterior femora and curved moderately and uniformly upwards.

Color wood-brown, the sides of the pronotum a little darker, the upper posterior portion shiny piceous; sides of the abdomen shiny black, strongly contrasted with the brown dorsum; posterior femora with two longitudinal black streaks on the outer face; ovipositor, legs, and face tinged with reddish brown.

Measurements.—Length, pronotum, 6 mm.; posterior femora, 18; ovipositor, 17; width, pronotum across the metazona, 3.5; posterior femora at narrowest point, 1, at widest point, 3.75; ovipositor, in the middle, 1.5.

Type.—Cat. No. 10189 U. S. National Museum.

Specimens examined.—One female, labeled "Colonia Garcia, Chihuahua, Mexico" (Townsend). The specimen was presented to the U. S. National Museum by Bruner.

The slight development of the thoracic carinæ and the absence of visible wings will readily separate this Mexican species from the United States forms.

CLINOPLEURA Scudder.

Clinopleura Scudder, Can. Ent., XXVI, 1894, pp. 179, 182; Guide N. A. Orth., 1897, p. 56; Cat. Orth. U. S., 1900, p. 79.—Kirby, Syn. Cat. Orth, II, 1906, p. 194.

Description.—Head large and prominent; vertex broad, fully half as broad as the interocular space and prominent; eyes oval, scarcely prominent. Pronotum of medium size and very moderately produced posteriorly; lateral lobes well developed, about as deep as long, very declivent, and scarcely sinuate posteriorly; lateral carinæ well developed, slightly convergent in the anterior sixth and then gradually divergent to the posterior border of the pronotum, where they are as widely separated as at the anterior border (fig. 84); median carina distinct, low but persistent; disk flat, very narrow, about four times as long as the posterior breadth, no more than one-half as broad as the prothorax through the lower margins of the lateral lobes, cut at the narrowest point, the point of convergence of the lateral carinæ, by an inconspicuous transverse sulcus; pronotal disk anteriorly truncate, posteriorly rounded. Prosternum unarmed. Legs long, posterior femora over three times as long as the pronotum, subparallel in the apical half or less, slightly swollen above apically and much and abruptly swollen basally (fig. 82), armed below on the inner side only with a few stout black spines; anterior tibiæ armed above on the outer side only with four spines, rarely with five. Wings aborted; elytra broad and apically broadly rounded, overlapping above in both sexes and projecting beyond the pronotum a distance equal to nearly or quite

one-half the length of the pronotum. Subgenital plate apically notched in both sexes, the side angles rounded in the female, in the male terminating in somewhat slender styles. Last abdominal segment of the male apically deflexed and roundly concave, similar in the female; supraanal plate of both sexes triangular, often difficultly seen but in some specimens fairly prominent, often, in the male, with a central pit extending nearly through the plate; cerci simple in both sexes, quite uniformly tapering in the female, in the male with the apex attenuate and bent inwards in the form of a hard, naked, black tooth. (Figs. 83 and 86.) Ovipositor straight, not as long as the posterior femora and abruptly pointed at the apex.

Type.—Clinopleura melanopleura Scudder.

The members of this genus are natives of the middle Pacific States, all the known species being recorded from California or Utah. They probably inhabit open fields, as Professor Morse has taken *C. melanopleura* in some numbers traveling about in grassy fields some distance from woods.

We have three species, one apparently undescribed. They may be separated by the following table:

KEY TO THE SPECIES OF CLINOPLEURA.

A. Size larger, pronotum 6 mm. or more in length.

B. Cerci of the male with the apical black naked portion one-third, or more, as long as the main body (fig. 83); pleura of both sexes with a light margin behind and below, generally contrasted strongly with the rest of the surface, which is black on the posterior portion and sometimes all over, *melanopleura*, p. 399

B′. Cerci of the males with the black apical portion about one-fourth as long as the main body (fig. 86); pleura of both sexes with the colors usually but little contrasted ..... *flavomarginata*, p. 401

A′. Size smaller, pronotum 5.5 mm. or less in length; cerci of the male with the apical black portion about one-fourth as long as the main body (fig. 86), *minuta*, p. 402

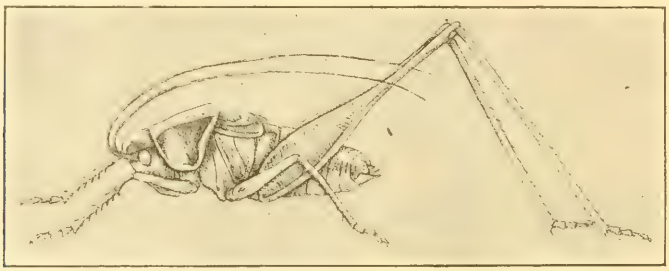
CLINOPLEURA MELANOPLEURA Scudder.

Steiroxys melanopleura Scudder, Ann. Rept. Chief Eng., 1876, p. 500; Ann. Rept. U. S. Geol. Surv. West 100 Merid., 1876, p. 280.

Clinopleura melanopleura Scudder, Can. Ent., XXVI., 1894, pp. 182, 183; Cat. Orth. U. S., 1900, p. 79; Can. Ent., XXXII., 1900, p. 332.—Woodworth, Bull, No. 142, Calif. Exp. Station, 1902, p. 15.—Kirby, Syn. Cat. Orth., II. 1906, p. 194.

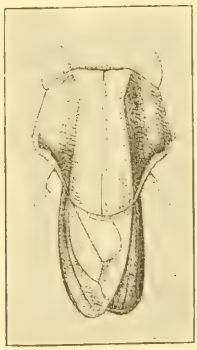
Description.—Head broader than the anterior portion of the pronotum, into which it is very slightly inserted; vertex prominent, one-half as broad as the interocular space, convex, not at all sulcate; eyes ovate, of medium size, not prominent; basal segment of the antenna scarcely more than one-fourth as large as the vertex as viewed from in front. Pronotum as described under the genus. Elytra of both sexes elongate, reticulated with conspicuous coarse veins. Legs very long, the posterior femora over three times as long as the pronotum

and much and abruptly ampliate on the basal three-fifths, being nearly four times as broad at the widest point as at the narrowest; anterior tibiæ armed above on the outer side only with four, or very rarely with five, spines. Cerci of the female cylindrical, about four times as long as the basal width, tapering to a point and apically curved somewhat inwards, of the male with the black naked apical portion nearly one-half as long as the main body and bent inwards at right angles with the main body and usually somewhat recurved (fig. 83), the basal portion subcylindrical, slightly tapering. Ovipositor (fig. 85) straight, considerably less than the posterior femora in length, the abruptly pointed apex smooth.

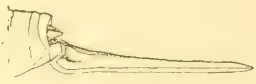


82

83



84



85

FIGS. 82, 83, 84, 85.—CLINOPLEURA MELANOPLEURA. 82, ADULT MALE. 83, CERCUS OF MALE. 84, PRONOTUM OF MALE FROM ABOVE. 85, OVIPOSITOR FROM THE SIDE.

Color light yellowish-brown, or, by variation, dark brown. The abdomen of typical specimens is slightly darkened on the sides, as are also the outer face of the posterior femora; the lateral lobes of the pronotum are more or less deeply infuscated, except the lower and posterior margins, which are always clear yellowish. The measurements of typical specimens are as follows:

Measurements.—Length, pronotum, male, 6.5–7 mm., female, 6.5–7.5; posterior femora, male, 23–26, female, 24–28; elytra, male, 3.5–4, female, 2.5–4; ovipositor, 19–23; width of the pronotal disk at the posterior margin, male, and female, 3.25–3.5.

Type.—In the Scudder collection.

Specimens examined.—I have examined nearly half a hundred specimens of this species. Professor Morse has a fine series of six males and eighteen females taken by himself at Tehachapi, California, in 1897. They were found traveling about in a grassy field some distance from any woodlands. Besides this series in the Morse collection and the material in the Scudder collection, which includes the type, I have seen specimens from Los Angeles County, California, and from San Bernardino and Atwater in the same State. A female taken at Valley Springs, California, July 28, 1885, by H. A. Mepinge, is colored, except the lateral lobes of the pronotum, which are margined as usual, uniformly dark brown, instead of light yellowish brown, and the measurements are somewhat less, being as follows:

Length, pronotum, 6 mm.; posterior femora, 21; elytra, 2.25; ovipositor, 16; width of pronotum at the posterior border of the disk, 2.25.

This specimen seems to form a variety worthy of a name, and I call it *Clinopleura melanopleura* var. *infuscata.*

Type.—Cat. No. 10190, U. S. National Museum.

A female in the Scudder collection is somewhat more infuscated than usual, tending towards this dark variety and proving the difference separating the variety from the typical form to be varietal and not specific. This dark variety is somewhat related to the following species, *flavomarginata*, but is much smaller, and the lateral lobes of the pronotum are more distinctly margined posteriorly with yellow.

CLINOPLEURA FLAVOMARGINATA Scudder.

Clinopleura flavomarginata SCUDDER, Can. Ent., XXXII, 1900, p. 332 (part).—KIRBY, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Very similar to *C. melanopleura*, in structure, except that of the cerci, practically the same. The color is testaceous with the infuscation of the lateral lobes of the pronotum less distinctly contrasted with the posterior margins than in *melanopleura.* The structure of the cerci of the male is quite different from than of *melanopleura*, the black shiny apical portion being only about one-fourth as long as the main body instead of nearly one-half as long, in this respect agreeing with the cerci of the following species, *minuta.* The measurements are as follows:

Measurements.—Length, pronotum, male and female, 6.75 mm.; posterior femora, male, 25.5, female, 26.5; elytra, male and female, 2.75; ovipositor, 19.

Types.—In the Scudder collection and the collection of A. P. Morse.

Specimens examined.—Several specimens of both sexes, all from California.

The specimens recorded in the original description as from Ahwanee, Raymond, and Calaveras, California, all belong to a different species herein described as new. The true types as here eliminated are all from Ceres, California, August 17, one pair in the Scudder collection and one male in the collection of Morse. An immature female in the collection of the National Museum is referred here with some doubt. It comes from Anaheim, Orange County, California (Coquillett).

Were it not for the different cerci of the male I would rather incline to the belief that this species is but a variety of *melanopleura*.

CLINOPLEURA MINUTA, new species.

Clinopleura flavomarginata SCUDDER, Can. Ent., XXXII, 1900, p. 332 (part).

Description.—In most particulars this species is like *melanopleura* except in size, which is much less than in either *melanopleura* or *flavomarginata*. The cerci of the male are like those of *flavomarginata*, the black apical portion being about one fourth as long as the main body (fig. 86). The color is testaceous or fusco-testaceous with the lateral lobes of the pronotum infuscated and margined below and behind with yellow. The elytra are comparatively about the same length and show about the same range of variation as those of the typical species. The size, however, is the most conspicuous differentiating feature, being as follows:

FIG. 86.—CLINOPLEURA MINUTA. CERCUS OF ADULT MALE.

Measurements.—Length, pronotum, male, 4.5–5 mm., female, 4.5–5.5; posterior femora, male, 19–22, female, 19–22.5; elytra, male, 2–3, female, 1.5–2; ovipositor, 13–16; width, pronotal disk at the posterior margin, male and female, 1.75–2.5.

Type.—Cat. No. 10191, U. S. National Museum.

Specimens examined.—Several specimens of both sexes from California.

Described from two pairs from Calaveras, California. In the collections of Scudder and Morse are examples from Ahwanee, Calaveras, and Raymond, California, some of them marked as types of *C. flavomarginata*. These specimens bear *flavomarginata* type labels and are mentioned in the original description but do not appear to enter materially into the description itself as the measurements are much below those given for *flavomarginata*. I have seen a male of *minuta* from Berkeley, California.

This is the smallest species of the genus and seems very distinct.

PLATYCLEIS Fieber.

Platycleis FIEBER, Lotos, III, 1853, p. 149.
Chelidoptera[a] WESMAEL, Bull. Acad. Brux., V, 1838, p. 591.—KIRBY, Syn. Cat. Orth., II, 1906, p. 203.

Description.—Female. Head quite small, deeply inserted into the pronotum; vertex very broad, about two-thirds as broad as the interocular space, moderately prominent; eyes medium in size, moderately prominent. Pronotum small and but slightly produced posteriorly; lateral lobes well developed, about as deep as long, very nearly vertical and very slightly sinuate posteriorly; lateral carinæ distinct, moderately sharp, persistent, a little more rounded on the extreme anterior margin of the pronotum, straight, uniformly expanding a little from the front backwards; median carina present only on the posterior third, moderately sharp; disk narrow, a little broader behind than in front and flat, marked just anterior of the termination of the median carina with a tolerably distinct U-shaped sulcus; the disk is subtruncate anteriorly and posteriorly. Prosternum unarmed; mesosternal lobes prominent. Elytra squamæform, overlapping above, rounded apically and projecting beyond the pronotum a distance equal to nearly one-half the pronotal length; wings about as long as the elytra but not so broad, lateral, not meeting above. Legs moderately long, the posterior femora more than twice as long as the pronotum, swollen on the basal three-fifths and unarmed below, the plantula of the hind tarsi scarcely one-half as long as the basal segment; anterior tibiæ armed above on the outer margin only with three spines. Abdomen moderately plump and dorsally subcarinate; subgenital plate apically roundly and shallowly notched; supraanal plate small, triangular and dorsally concave, almost concealed beneath the last abdominal segment, which is broad, centrally concave and mesially incised apically for nearly its entire length by a narrow cleft; a pair of perpendicular infracercal plates embrace the supraanal plate, which they equal in length; cerci simple, conical, hairy; ovipositor curved strongly upwards and about as long as the posterior femora.

Type.—*Decticus intermedius* Serville.

This is the only old world genus represented, so far as known, in our fauna. But one species is known, the following:

PLATYCLEIS FLETCHERI, new species.

Description.—Female, male unknown. Head scarcely as broad as the anterior portion of the pronotum; vertex convex, broad and moderately prominent; eyes medium in size and prominence, rounded; basal segment of the antenna broad, almost one-half as large as the

[a] Preoccupied in ornithology by *Chelidoptera* Gould, Proc. Zool. Soc. Lond., 1836, (1837), p. 81.

vertex as viewed from in front. Pronotum narrow, structure as described under the genus. Wings narrower but about as long as the elytra, which are apically broadly rounded, overlap dorsally and project beyond the pronotum about one-half the pronotal length. Legs of moderate length and size; posterior femora more than two times as thick basally as apically, the swelling confined to about the basal three-fifths: anterior tibiæ unarmed above on the inner side, on the outer side armed with three spines. Abdomen and genital characters as described under the genus.

FIG. 87.—PLATYCLEIS FLETCHERI. ADULT FEMALE.

Color dark reddish brown, the posterior tarsi and the sides of the vertex black and the disk and the central portions of the lateral lobes of the pronotum nearly black, the latter bordered below and behind with yellowish.

Measurements.—Length, pronotum, 5.25 mm.; elytra, 2.5; posterior femora, 14.5; ovipositor, 14; width, pronotal disk at the posterior margin, 3.75; at the anterior margin, 2.75.

Type.—Cat. No. 10192, U. S. National Museum.

Specimens examined.—The type, one female (fig. 87), taken by Dr. James Fletcher at Calgary, Assiniboia, Canada, on July 31, 1904, and by him presented to the U. S. National Museum.

I take pleasure in naming this interesting insect in honor of its illustrious collector.

STEIROXYS Herman.

Steiroxys HERMAN, Verhandl. der k. k. Zool.-Bot. Gesellsch. Wien, XXIV, 1874, pp. 200, 207.—SCUDDER, Can. Ent., XXVI, 1894, pp. 179, 182; Guide N. A. Orth., 1897, p. 56; Cat. Orth. U. S., 1900, p. 78.—KIRBY, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Head small, not prominent, deeply inserted into the pronotum; vertex moderately prominent and exceedingly broad, almost as broad as the interocular space; eyes small, scarcely prominent; basal segment of the antenna less than one-fourth as large as the vertex as viewed from in front. Pronotum of medium size, moderately produced posteriorly; lateral lobes well developed, nearly as deep as long, slightly declivent and somewhat sinuate posteriorly; lateral and median carinæ distinct and persistent, the former subparallel, diverging slightly from in front backwards (fig. 89); disk nearly flat, subrectangular, subtruncate both in front and behind, about two or two and one times as long as broad and without conspicuous sulci, some-

times with a noticable V-shaped one near the center. Prosternum unarmed. Elytra of female short, rounded lateral pads, scarcely projecting beyond the posterior edge of the pronotum, of the male broad, overlapping dorsally and projecting beyond the pronotum a distance equal to about one-half the length of the pronotum. Legs long, the posterior femora two and one-half times to nearly four times as long as the pronotum, strongly expanded on the basal two-thirds and unarmed beneath or armed with a few small spines; anterior tibiæ armed above on the outer side only with three spines; abdomen moderately plump, scarcely carinate; subgenital plate of both sexes apically rectangularly incised, that of the male with moderately prominent styles at each side behind; supraanal plate small and apically triangular in both sexes, closely fitted between a pair of compressed infracercal plates, usually hidden beneath the last abdominal segment, which, in the male, is mesially incised; cerci of the female simple, cylindrical, pointed, of the male cylindrical with the apex sharp and tooth-like, bent inwards and furnished on the inner side with a sharp tooth; ovipositor very slightly curved upwards and of a length varying from distinctly shorter than the posterior femora to somewhat longer.

Type.—Thamnotrizon trilineatus Thomas.

The type of this genus was originally described as having the pronotum without carinæ but in the description of the genus *Steiroxys* Herman says that this was probably a clerical error. That this is probably the case is indicated by several facts. Specimens of the type species labelled in the handwriting of Thomas as type specimens are in the National Museum and they have the pronotum carinate. Glover has figured the species, presumably from authentic specimens from Thomas, and his illustration shows the pronotum to be carinate. Besides this Thomas himself practically admits the correctness of Herman's diagnosis as based on *trilineatus*.[a] Thus *trilineatus* is seen to have a carinate pronotum and the statement to the contrary in the original description is to be attributed to a clerical error.

The classification of this genus is by far the least satisfactory of any of the group here treated. The cerci of the males are either unusually variable for this group or indicate several more species than I have recognized. That the cerci of the males, which are unvarying characters of such synoptic value in other genera of the group, should be so variable as to be useless as a differentiating character in this particular genus is, to say the least, odd. It may, however, eventually result that we have several more species than here considered but at this time I am unable to recognize such to be the case. The sexes are connected only by association with localities, none, so far as I know, having been taken in copulation. Color, so far as determinable from the material studied, is of little constancy. About fifty specimens of

[a] Rept. U. S. Geol. Surv. W. 100 Mer., V, 1875, p. 906.

the genus have been studied but much more material and field observation is necessary to satisfactorily place the various forms. The genus is distinct and very well circumscribed but the species seem in a hopeless state of chaos. The females are, at the present state of our knowledge of the genus, practically inseparable. Scudder has, it is true, published a table of species based upon characters supposedly of synoptic value but a study of type material in his collection shows some of the characters used by him in his table to be inversely true. Thus the pronotal disk of *borealis* is more nearly twice as long as broad as is that of *pallidipalpis*. The length of the posterior femora varies as does the color. Therefore, I have made no attempt to synoptically separate the various forms, this being deemed impracticable at this time. The described species are as follows:

STEIROXYS TRILINEATA Thomas.

Thamnotrizon trilineatus THOMAS, Proc. Acad. Nat. Sci. Philad., 1870, p. 76; Ann. Rept. U. S. Geol. Surv. Terr., II, 1871, pp. 265, 268.—GLOVER, Ill. N. A. Ent., Orth, 1872, pl. VIII, fig. 5.—SCUDDER, Index N. A. Orth, 1901, p. 322.

Decticus trilineatus THOMAS, Ann. Rept. U. S. Geol. Surv. Terr., V, 1872, p. 443.—BRUNER, Bull. No. 27, Div. Ent. U. S. Dept. Agric., 1892, p. 31.—SCUDDER, Index N. A. Orth, 1901, p. 95.

Dectes trilineatus BRUNER, Publ. Nebr. Acad. Sci., III, 1893, p. 31.

Steiroxys trilineata HERMAN, Verhandl. der k. k. Zool.-Bot. Gesellsch. Wien., XXIV, 1874, p. 207, pl. v, figs. 64–69.—SCUDDER, Can. Ent., XXVI, 1894, pp. 182, 183; Cat. Orth. U. S., 1900, p. 79; Index N. A. Orth., 1901, p. 300.—SCUDDER and COCKERELL, Proc. Davenp. Acad. Nat. Sci., IX, 1902, p. 55.—KIRBY, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Head small and deeply inserted into the pronotum; vertex convex and moderately prominent, very broad, occupying practically all the interocular space; eyes of moderate size, rounded and not prominent. Pronotum and wings as described under the genus. Legs moderately long, the posterior femora about three times as long as the pronotum, swollen on the basal two-thirds and unarmed below; anterior tibiæ armed above on the outer side only with three spines, rarely one of them missing. Abdomen plump, dorsally subcarinate; cerci of the female round, about four times as long as the basal width and tapering to a point, tapering mostly in the apical half; cerci of the male (fig. 91) cylindrical or somewhat flattened and tapering gradually to a point, curved downward and inward at the tip, and furnished on the inside about or just beyond the middle with a slightly recurved tooth cylindrical and shaped like the end of the main body; ovipositor about as long as the posterior femora and curved somewhat upward, the tip abruptly tapering to a point and roughened by minute serrations.

Color dark brown or yellowish, usually with some lighter markings down the dorsum, sometimes lighter with a row of conspicuous V-

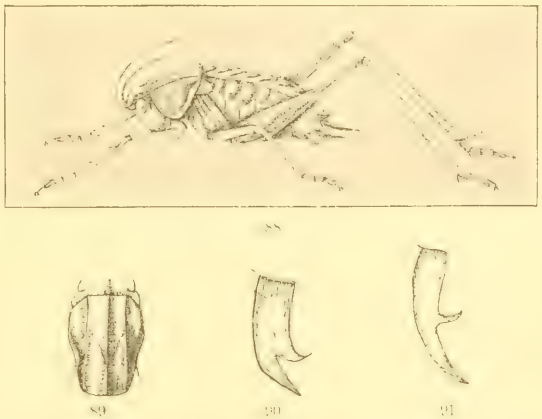
shaped black marks down the top of the abdomen and a row of oblique black dashes along the sides (fig. 88). The lateral lobes of the pronotum are generally bordered below and behind with yellowish, and next this yellow border behind is usually a piceous streak.

Measurements.—Length, pronotum, male, 5.5–6 mm., female, 4.5–6; posterior femora, male, 18–19, female, 15.5–19; elytra, male, 2–3, female, 5–1; ovipositor, 16–24; width, pronotum at posterior margin, male, 3–3.25, female, 2.5–3.

Type.—Apparently lost.

Specimens examined.—Material from Nebraska, Colorado, Montana, and Idaho.

The National Museum contains specimens labeled as types, but erroneously so, as the species was described from southeast Colorado, while these specimens are from South Pass, Wyoming; but they are doubtlessly authentic specimens, being labeled in the handwriting of Thomas. Besides these, the National Museum contains specimens, all females, from Nebraska, Colorado, Montana, and Idaho. Besides these localities the species has been recorded from Utah, Wyoming, and New Mexico.



FIGS. 88, 89, 90, 91.—STEIROXYS TRILINEATA. 88, ADULT FEMALE. 89, PRONOTUM OF FEMALE FROM ABOVE. 90, CERCUS OF ADULT MALE. 91, CERCUS OF ADULT MALE.

The figure by Glover is not a good one, failing, as it does, to properly show the thoracic carinæ.

Besides the statement that the pronotum is without carinæ the original description contains some other minor points at variance with the characters of the specimens now considered as this species. But, as stated in the discussion under the genus, Herman's construction is accepted.

There is an immense amount of variation in color and general appearance of the specimens here referred to this species. Some specimens are light, with conspicuous abdominal markings and with short legs and ovipositors, as shown in fig. 88, and others are very uniformly brownish or greenish yellow, with long posterior femora and ovipositors, while still others have the conspicuous abdominal markings, but with long posterior femora and ovipositors. The cerci of the males sometimes have the tooth situated at the middle (fig. 91).

and sometimes much beyond the middle (fig. 90); in some specimens the location of the cercal tooth is intermediate between the two figured.

There may be more than one species represented among the specimens here referred to this species, but if so, I am unable to satisfactorily separate them.

STEIROXYS PALLIDIPALPUS Thomas.

Decticus pallidipalpus Thomas, Ann. Rept. U. S. Geol. Surv. Terr., V., 1872, p. 442; Proc. Davenp. Acad. Nat. Sci., I, 1876, p. 262.—Scudder, Index N. A. Orth., 1901, p. 95.

Steiroxys pallidipalpus Scudder, Can. Ent., XXVI, 1894, pp. 182–183; Cat. Orth. U. S. 1900, p. 78; Index N. A. Orth., 1901, p. 300.—Rehn, Ent. News, XVII, 1906, p. 288.—Kirby, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Head medium in size, inserted into the pronotum a moderate depth; vertex broad, convex, much broader than the eye, which is considerably smaller in the female than in the male. Pronotum moderate in size and in posterior prolongation, the lateral lobes deep, almost vertical, with a slight posterior sinus; lateral carinæ prominent, sharp, persistent, in both sexes diverging very slightly posteriorly. Pronotal disk nearly flat, slightly rising from the lateral carinæ to the distinct, persistent, median carina; the disk is truncate behind and in front, or very slightly rounded anteriorly, without sulci. Wings and legs as in *trilineata*, the posterior femora sometimes with a few small spines beneath. Abdomen as in *trilineata*. Cerci of the female about four times as long as the basal width, of the male heavy basally, tapering abruptly just beyond the inner tooth, which is situated at or before the middle, the apex sharp and bent inward (fig. 92). Ovipositor long, slightly curved upward and unarmed apically, curving somewhat more in the basal portion than that of the following species.

Fig. 92.—Steiroxys pallidipalpus. Cercus of adult male.

Color yellowish or light brown, the posterior femora mottled more or less with fuscous; lateral lobes of the pronotum in the male slightly infuscated posteriorly and with a yellow margin above the sinus, in the female about the same, but less distinct. Ovipositor dark reddish brown.

Measurements.—Length, pronotum, male, 6.75 mm., female, 7; posterior femora, male, 18.5–24.5, female, 19–20; elytra, male, 3.5, female, 1; ovipositor, 18.5–22; width, pronotum at posterior margin, male, 4.5, female, 4.

Type.—Apparently lost.

Specimens examined.—Specimens from Nevada, Oregon, Idaho, Wyoming, Washington, and California.

The above description, except the minimum measurements, which

are taken from Thomas's original description, was drawn up from a male in the Scudder collection from Ruby Valley, Nevada (Ridgeway), and a female in the Morse collection from Mary's Peak, Benton County, Oregon, September 16, 1897. This female may be wrongly associated but the male is very certainly properly placed. The species has also been recorded from Utah and Idaho.

The cerci of the male in this species seems to represent a type derived from that of *S. trilineata*, the inner tooth having become slightly smaller and moved back toward the base (fig. 93). The two forms of cerci are, however, quite distinct.

The National Museum contains one much shrivelled female from Idaho, evidently preserved in spirits and afterwards dried, which is labeled in the handwriting of Professor Thomas as questionably *S. pallidipalpus*. Also one female from Pocatello, Idaho, one without label and a male from east Washington. This male, which is referred here with some doubt, has the cerci shaped as shown in fig. 93, and the posterior femora measure 22 mm. in length. Bruner has a number of both sexes from Washington, Idaho, Wyoming, and California. Rehn records it from Utah.

FIG. 93.—STEIROXYS PALLIDIPALPUS, CERCUS OF ADULT MALE (VARIETY).

The specimen figured by Glover[a] as this species is very surely wrongly identified, probably belonging to the genus *Eremopedes* or *Stipator*.

STEIROXYS BOREALIS Scudder.

Steiroxys borealis SCUDDER, Can. Ent., XXVI, 1894, p. 182; Index N. A. Orth., 1901, p. 300.—WOODWORTH, Bull., p. 142, Calif. Exp. Stat., 1902, p. 15.—KIRBY, Syn. Cat. Orth., II, 1906, p. 194.

Description.—Head and pronotum as in *S. trilineata*. Elytra of the male projecting scarcely one-half the length of the pronotum, broad, overlapping above, of the female slightly projecting lateral lobes. Legs moderately long; the posterior femora swollen on the basal two-thirds and unarmed beneath; anterior tibiæ armed above on the outer side only with three spines. Abdomen moderately heavy, dorsally subcarinate; cerci of the female conical, variable in length, sometimes seemingly less than four times as long as the basal width while in some specimens referred here they are fully five times as long. The cerci of the male are strikingly different from those of either of the preceeding species, being basally much compressed, no more than one-half as broad as deep and apically divided into two equal incurved hard black claws (fig. 94). Ovipositor moderately stout, scarcely as long as, or but little longer than, the posterior femora, slightly curved upward, apically pointed and unarmed.

[a] Ill. N. A. Ent., Orth., 1872, pl. IX, fig. 8.

Color brown, usually with a pair of more or less distinct narrow pale subdorsal lines on the abdomen.

Measurements.—Length, pronotum, male and female, 6–7 mm.; posterior femora, male, 18–5, female, 17.5–20; elytra, male, 3, female, 0.5–1; ovipositor, 15–21; width, pronotum at posterior margin, male, 3.25, female, 3.5.

Type.—In the Scudder collection.

Specimens examined.—The types from northern California and specimens from Oregon, Washington, Wyoming, and British America.

FIG. 94.—STEIROXYS BOREALIS. CERCUS OF ADULT MALE.

The above description, with the exception of certain measurements, was drawn up from a male from northern California, from the old Uhler collection, and a female from Oregon, no locality given. These are Scudder's types. In the collection of the Museum of Comparative Zoology at Cambridge, Massachusetts, are a number of female specimens from Oregon in which the ovipositors are almost straight. The National Museum contains several specimens, all females, which are referred here. They are from Pullman, Washington, July and August; Jackson's Hole, Wyoming, August; Fort McLeod, British America, August, and one without label. These specimens are referred here by locality rather than by any noticeable differences separating them from dark forms of *trilineata*.

ADDITIONAL NOTES ON THE DEVELOPMENT OF THE ARGULIDÆ, WITH DESCRIPTION OF A NEW SPECIES.

By Charles Branch Wilson,
Department of Biology, State Normal School, Westfield, Massachusetts.

INTRODUCTION.

This fifth paper in the series based on the Collection belonging to the U. S. National Museum gives for the first time an account of the newly hatched larvæ of two of our common Argulids, one, *Argulus funduli*, a salt-water form, and the other, *Argulus maculosus*, found only in fresh water.

It also gives a description and figures of the male of *Argulus catostomi*, which is the oldest of our North American species.

In each of the three instances the form here described is the only one needed to complete a full account of the species, including its life history. We have now, therefore, six native species whose entire development is known, two infesting marine fishes and the other four those inhabiting fresh water.

For the opportunity of obtaining the present material the author is indebted again to the courtesy and assistance extended by the Bureau of Fisheries. The larva of *Argulus funduli* was obtained during the summer of 1905 while the author was working as a temporary assistant at the station of the Bureau of Fisheries at Beaufort, North Carolina. The other two forms were obtained during the present summer, 1906, while holding a similar position at Lake Maxinkuckee, Indiana. Grateful acknowledgment is here made for these favors.

I. THE MALE OF ARGULUS CATOSTOMI Dana and Herrick.

This was the first American Argulid to be described. For this reason and also because of the excellent figures given by Dana and Herrick with their original description, it was at once accepted by European scientists and has taken the same place in America that is occupied by *Argulus foliaceus* in the European fauna. But Dana and Herrick did not secure any specimens of males, and consequently their species diagnosis was based entirely upon females. This has been the

case with every zoologist since their day also. Even the present author, in a previous paper on the Argulidæ, was forced to be content with the one sex in consequence of an unfortunate accident which destroyed the few male specimens he possessed.

Accordingly this, the best known and one of the most widely distributed American species, has waited almost seventy years for the completion of the original diagnosis.

In the spring of 1905 the author visited the State fish hatchery at Swanton, Vermont, on the Missequoi River, near the shores of Lake Champlain. At this station are hatched every year many millions of the eggs of the wall-eyed pike, *Stisostedion vitreum*, one of the most common food fishes in the lake and its tributaries. The females are obtained for stripping by means of seines, and through the superintendent of the station permission was obtained from the State authorities to examine all the fish taken in the seines. For this and for many other courtesies the author acknowledges his indebtedness to the superintendent, who kindly placed at his disposal every facility which the station afforded.

Among other fish obtained were several red-fin and black-fin suckers, *Catostomus nigricans* and *C. catostomus*, and from these were taken about twenty specimens of *Argulus catostomi*, five of which proved to be males. Both sexes of this species were also obtained from the black sucker, *C. catostomus*, caught in Lake Maxinkuckee, Indiana, in August, 1906.

None of these specimens were as large as those obtained by the author from the same sucker in Massachusetts, but which were accidentally destroyed. Swanton, Vermont, is a long way from Mill River in Connecticut, where Dana and Herrick secured their specimens, and Lake Maxinkuckee is even farther removed.

Furthermore, the water is entirely fresh in both these localities instead of being brackish. But the one lot of material supplements the other and enables us to complete the account begun so long ago.

ARGULUS CATOSTOMI Dana and Herrick.

Plate XXIX, figs 1–9.

The Male.—Carapace orbicular, about one-tenth wider than long, with evenly rounded sides. Posterior sinus very wide, especially at the base, and a little more than one-third the length of the carapace. Grooving of the dorsal surface like that of the female. Abdomen elliptical and relatively much larger as would be expected in this sex, about one-third the length and one-fourth the width of the carapace. Testes elliptical, pear-shaped, and fully three-fifths the length of the abdomen, their dorsal surface sprinkled with small dots of dark pigment. Anal sinus wide, less than one-third the length of the abdomen;

papillæ basal and minute. The accessory sexual characters are very prominent and markedly different from those of any other species.

In the fourth legs both joints of the basipod carry a flap, heavily fringed with plumose setæ on their posterior margin, that on the basal joint being several times larger than that on the proximal. The peg on the anterior margin of the proximal joint is quite similar to that in *Argulus versicolor*, but relatively larger. The two parts of the peg, basal and terminal, are more clearly defined than in any species yet examined, and together make a pear-shaped organ with an evenly rounded outline. The tip of the tube is enlarged and surrounded by a fringe of minute hairs as in other species. The basal portion of the peg connects on the inside of the leg with a long spindle-shaped receptacle which extends inward through both joints of the basipod and almost to the mid-line of the body. Its walls are muscular and no doubt aid in ejecting the sperm.

In the third legs the proximal joint of the basipod is semi-lunar and the ends curve outward in long flaps, one in front of and the other behind the terminal joint. The posterior flap is wide and bluntly rounded at the tip; it carries a heavy fringe of plumose setæ and reaches only to the center of the distal basipod joint. The anterior flap is narrower and tapers to a long curved point which overlaps the base of the exopod for some little distance. There are no plumose setæ on its margin, but instead its entire dorsal surface is covered with small spines.

The distal joint of these third basipods bears the semen receptacle which is also similar to that of *Argulus versicolor*, except that the opening is nearer the center on the dorsal surface, instead of being at the posterior margin.

There is also a cone-shaped funnel extending forward from the anterior margin of the opening, along the dorsal surface of the basipod. This cone has a slit running along the dorsal side for the whole length; the outside of the cone and the inside at the tip are covered thickly with small spines.

The receptacle inside these legs is cylindrical and extends inward, like that of the fourth legs, through both basipod joints and into the third thorax segment.

The base of the exopod of these legs is enlarged on its anterior border where it joins the basipod into a rounded knob thickly covered with short spines.

The basal joint of the second legs bears a small flap on its posterior margin and ventral surface similar to those on the other legs but much smaller. It carries only four plumose setæ, at its outer end. The distal joint of the basipod of the first and second legs is armed with a flagellum, which projects from its ventral surface at the outer anterior corner.

The reproductive organs are very prominent, being colored a cinnamon brown, which stands out in strong contrast to the surrounding gray and yellow. From the anterior end of each of the large testes a vas efferens leads forward to the semen receptacle, which is situated in the second thorax segment.

The vasa deferentia given off from the anterior end of this receptacle are very large at their bases and project somewhat into the first thorax segment. They taper gradually backward to the fourth segment, where they curve down on the outside of the vasa efferentia and meet below in the common ejaculatory duct.

Color of the Lake Champlain specimens a grayish green, similar to that of the female, the ventral surface of the thorax in the male and in several young females taken with them being sparsely covered with small spots of a brick-red pigment.

Color of the Lake Maxinkuckee specimens a light grayish brown, without any tinge of green. Eyes dark brownish black, brain a purplish hue, reproductive organs a dark cinnamon brown.

The ventral surface of each testis has a long line of the same dark brown running through the center lengthwise, the line becoming bifurcate toward the posterior end.

On the ventral surface of each joint of the thorax at the center and on the basipods of the swimming legs are small spots of brick-red pigment.

Total length 5–6 mm.; length of carapace 4.5 mm., of thorax 1.5 mm., of abdomen 1.35 mm. Width of carapace 4.8 mm.

II. THE LARVA OF ARGULUS FUNDULI Kröyer.

Plate XXX, figs. 10–14.

Only a single larva, that of *Argulus megalops*, of the true salt water Argulids has been described up to the present time.

The one here presented is therefore the second and is of peculiar interest in that it substantiates many of the characters in which the *megalops* larva was found to differ from the fresh-water forms. Two ripe females of *Argulus funduli* were obtained from *Fundulus heteroclitus* at Beaufort, North Carolina, on August 4, 1905. On being placed in fresh sea water one of the females deposited her eggs; these were then kept in a small glass surrounded by running sea water at a constant temperature of about 27° C. The eggs began to hatch on August 22, eighteen days after being laid. This is in marked contrast with the *megalops* larvæ, which required sixty days of incubation, but it shows that there is the same difference between the salt-water forms that we find in fresh-water species.

The eggs of *Argulus funduli*, therefore, among the salt-water forms correspond with those of *A. americanus* and *A. maculosus* from fresh

water. Furthermore we are certain that in the present instance the period of development is normal, for these eggs were kept at the same temperature as the ocean water in which they would naturally have been laid. The following is a description of the larvæ obtained:

Carapace heart shaped, a little wider than long; not much narrowed anteriorly; its entire margin fringed with delicate hairs, amongst the anterior two-thirds of which are scattered longer tactile hairs. Posterior sinus very shallow, the lateral lobes wide and well rounded. The large eyes are placed well forward and are widely separated. The cephalic area is clearly differentiated from the lateral areas at the sides and from the thoracic area posteriorly, and considerable movement is possible between these areas. The skin glands are not as large as those of the *megalops* larvæ, but there is a row of ten or twelve of medium size on either side parallel with the margin of the posterior portion of the lateral lobes.

The first antennæ, like those in the *megalops* larva, have assumed nearly their permanent form. The basal joint is armed with a broad and blunt posterior spine, and the usual sickle-shaped claw on its lateral margin. The terminal joints are comparatively stout and do not project much beyond the claw of the basal joint. The second antennæ are also of the adult form, slender, four jointed, and terminating in a small claw.

On the ventral surface, inside the base of these antennæ and immediately behind the large posterior spine of the first pair on either side, is another spine of the same size and shape.

The first maxillipeds are very large and stout and three jointed, the basal joint much swollen and bearing on its ventral surface near the distal end two large flat spines.

The second joint is much shorter and narrower, though still stout; the terminal claw is sickle-shaped, with the usual three barbs on its inner margin at the tip. The posterior maxillipeds are large and stout also, the basal joint with a pair of strong spines on its posterior border, the terminal joint with two stout and movable claws and a straight, rounded knob.

The ventral surfaces of the three middle joints are well armed with flattened laminæ, one edge of which is raised and cut into long and sharp teeth. Between the bases of these maxillipeds, on either side of the mid line, is a slender and sharp spine.

The mouth tube is short and wide, with a framework quite similar to that in *megalops*. The mandibles, however, are not toothed along their inner border, and there are no labial palps visible. The retractile proboscis is comparatively large and stout. Free thorax segments wide and quite long, leaving considerable space between the posterior border of the carapace and the abdomen. Each segment carries a pair of swimming legs fully developed and of practically the

same form as in the adult, with the exception that the endopod of the first pair is three jointed instead of two jointed.

Abdomen large and regularly elliptical, being a little longer than wide; anal sinus deep and triangular, the lobes on either side evenly rounded; anal papillæ large and basal, each armed with four long curved setæ which reach well beyond the posterior margin of the abdomen. We do not find in this abdomen the few large skin glands on either side which were so prominent in the *megalops* larvæ, but instead a large number of tiny glands scattered over the entire dorsal surface, with a row of six or seven on either side of the intestine a trifle larger than the rest.

Total length, 0.66 to 0.7 mm. Length of carapace, 0.43 mm. Width of carapace, 0.47 mm. Length of free thorax, 0.147 mm. Length of abdomen, 0.125 mm.

The larva of *A. funduli* thus takes its place with those of *A. megalops* and *A. stizostethii* as one in which most of the metamorphosis takes place within the egg before hatching.

Like the two species mentioned the larva, when it does come forth, has the same appendages and structure as the adult, with the single exception of the first maxillipeds. Even these, however, are prehensile, although by means of a claw instead of a sucking disk. As soon as they come out of the egg these larvæ begin to swim by means of the same appendages which they are to use through life. In the case of *megalops* and *stizostethii* this is what would naturally be expected, the former spending sixty and the latter eighty days in the egg.

But these *funduli* larvæ hatched in eighteen days, and it is at least noteworthy that they were able to reach the same advanced development in so small a fraction of time.

The digestive tract and the circulatory apparatus are not as far advanced in the present species as in *megalops*, and presumably in *stizostethii*, although we have no record in this respect for the latter species. But in external morphology, and particularly in the locomotor apparatus, these eighteen-day larvæ have fully reached the same advancement as the other two species.

III. THE LARVA OF ARGULUS MACULOSUS Wilson.

Plate XXXI, figs. 15–22.

Two females of this species with ripe eggs were obtained at Lake Maxinkuckee, Indiana, August 8, 1906, from the redeye, *Ambloplites rupestris*. It was afterwards found that this was not their true host, but only a temporary one, used while they were searching for a suitable place to deposit their eggs.

Numerous specimens of both sexes were subsequently obtained from the two catfish, *Ameiurus natalis* and *A. nebulosus*, which are evidently

their true hosts. As the previous description[a] of this species was made entirely from preserved specimens, it will be well to note here the color of the living adults.

The body in both sexes is beautifully transparent and of a soft yellow color, like rich cream. Against this background the grooves on the dorsal surface of the carapace and the spots over the semen receptacles in the female and over the testes in the male show a clear cinnamon brown, while the claws and spines on the ventral surface are a darker brown, tinged with reddish.

The small spots which cover the entire dorsal surface, and from which the species was named, are a light brown, distinctly visible even to the naked eye.

The two females deposited their eggs that same evening upon the sides of a wide-mouthed bottle in which they had been placed.

The eggs were arranged in single straight rows, not end to end like those of *megalops*, but the first one inclined to the right, the second to the left, the third to the right, and so on.

The jelly envelope assumes a form characteristic of this species and much resembling that in *A. catostomi* and *A. americanus*, with this difference. In *catostomi* the jelly hardens into rows of papillæ, all about the same size, and running lengthwise of the egg; where the eggs come together these papillæ rows simply fuse into one another. In *americanus* there are similar longitudinal rows in which the papillæ are the same size, and in addition there are also a few scattered masses of jelly, some of which are nearly two-thirds as large as the entire egg. But they are scattered at random, and there are never more than one or two for each egg. Here in *maculosus* the longitudinal rows are the same as in the other two species, and there are in addition the large masses of jelly. But instead of being scattered they are arranged with perfect regularity, a row of them standing out like the spokes of a wheel at the junction of every two eggs, and at right angles to the long axis of the egg row.

The eggs are twice the size of those of *americanus*, measuring 0.64 by 0.43 mm., exclusive of the jelly envelope. They are light yellow and transparent when first laid, but become darker and opaque about the fourth day. The eyes appeared on the eleventh day, and the eggs began to hatch on August 24, sixteen days after they were laid, about the same length of time as that required for the *americanus* eggs. They did not all hatch at once, but kept coming out for about sixty hours. They were kept immersed in the lake for the first twelve days, the temperature of the water for that time averaging 76° F. They were then removed to an aquarium in which the water temperature stood nearly constantly at 72° F.

[a] Proc. U. S. Nat. Mus., XXV, p. 715.

The newly hatched larvæ are sluggish and move about slowly like those of *americanus*, but they do not stick to the bottom of the dish like the latter. Moreover, their motion is not jerky and cyclops-like, but is similar to that in the adults. They are beautifully transparent, the small amount of pigment present only serving to bring out more clearly the internal anatomy. The following is a description of these larvæ:

Carapace broadly elliptical, the width to the length in the proportion of 13 to 16; anterior margin broad and rounded, with a fringe of long cilia, among which are scattered tactile hairs; as in other species. The posterior sinus is broad and shallow, while the free thorax and abdomen form a wide triangle relatively shorter than in other species. The first free segment is considerably less than half (five-thirteenths) the width of the carapace; the remaining segments and the abdomen diminish regularly in size. The abdomen is relatively smaller than in any other species; its shape is that of three-quarters of a circle, the chord forming the base, while the diameter is considerably less than the width of the last thorax segment.

The anal laminæ are close together, small, slightly divergent, and each carries two or three spines, of which the inner is the longer.

The first antennæ are three-jointed, the two terminal joints approximately spherical, the basal joint large and armed with a powerful hook. The curve of this hook reaches to the tip of the terminal joint, while in the *americanus* larva it scarcely reached the center of the second joint.

The second antennæ are similar to those of the *foliaceus* larva, but the two joints of the basal portion are very unequal, the distal one being fully twice as large as the proximal.

The temporary exopod is without joints and of the same length as the endopod, while this latter, which is permanent, has three joints increasing regularly in length, the terminal one the longest and tipped with a short curved claw and a pair of bristles.

The temporary mandibular palps are situated as far forward as in the *americanus* larva and are three-jointed. The spine connected with their base is outside of the mouth tube, straight instead of curved, and much nearer the mouth opening than in other larvæ. In fact, the tip of the spine is almost on a level with the rim of the mouth opening.

The anterior maxillipeds are stout and four-jointed and terminate in the usual pair of sickle-shaped claws, the dorsal one of which is barbed. The large cells in the basal joint which are to form the sucking disk are not apparent when the larva is first hatched, but can be seen forming two or three days afterward. The posterior maxillipeds are large and five-jointed, each joint armed on its ventral surface with spines and bristles. The terminal joint ends in two small and strongly curved claws and a conical papilla, tipped with a single minute spine, which frequently gets broken off. There is a stout spine on the

posterior border of the basal joint and a still longer one farther in on the ventral surface of the carapace close to the mid-line.

Of the swimming legs the first pair only are developed, the others being immovable stumps. This first pair consists of two basal joints, the distal one much the smaller and armed with spines on its ventral surface, and two rami. The endopod is three-jointed, each basal joint armed with a long spine at its distal end and shorter ones on its ventral surface, the terminal joint ending in two short spines. The exopod is one-jointed, with bristles along its anterior margin and two long nonplumose setæ at the tip. The leg stumps of the other pairs show plainly the division into endopod and exopod, the latter of which is tipped with two short spines, the former with only one, while both are covered on their ventral surface with small spiny hairs.

The internal anatomy is similar to that of other species already described. The digestive tract is not as well formed as in the *americanus* larva, and there is only the faintest trace of the shell glands in front of the side branches of the stomach. The chitin rings in the posterior lobes of the carapace are prominent and already possess the same shape as in the adult, and so are characteristic of the species.

The only other part deserving special mention is the skin glands. In the *americanus* larva there was only a single small group of these glands on either side near the posterior edge of the carapace lobes. In the present larva no skin glands at all are visible on first hatching; very small ones afterwards appear in the posterior carapace and the abdomen.

IV. ARGULUS APPENDICULOSUS, new species.

Plate XXXII, figs. 23–30.

Carapace orbicular, longer than wide, projecting slightly anteriorly, with broad and well-rounded posterior lobes, which just reach the abdomen in the male but fall a little short in the female. Posterior sinus broad, its sides slightly divergent, showing in dorsal view the bases of the posterior legs on either side of the last two or three thorax segments. Eyes small, situated far forward and well separated; cephalic area nearly as wide posteriorly as anteriorly, with evenly rounded sides. Chitin rings in the lobes of the carapace large and well defined, having the same general pattern as in *A. catostomi*, *americanus*, and *versicolor*, namely, an outer larger, semilunar ring with a much smaller spherical one inserted in its inner border near the anterior end.

In the present species the anterior portion of the outer ring, in front of the spherical ring, is larger than usual and reaches almost to the center of the disks of the first maxillipeds.

The spherical rings are relatively smaller than in the species mentioned and are buried more deeply in the sides of the large rings.

Abdomen small, one third the length of the carapace, nearly as wide as long, and ovate. Anal sinus reaching just to the center of the abdomen; posterior lobes triangular, slightly divergent and very wide at the base, almost obliterating the anal sinus. Anal papillæ minute and basal, almost concealed between the bases of the posterior lobes.

First antennæ stout, the claw twice the length of the rest of the basal joint and stoutly curved; the two terminal joints minute and scarcely reaching the tip of the claw.

At the base of these antennæ is a pair of stout spines, one on either side of the mid-line and some distance from it; each is strongly curved outward. Second antennæ small, no longer than the first, the joints diminishing regularly in size, the last three armed with bristles in the usual manner.

Mouth-tube stout and somewhat swollen at the tip; mouth opening subterminal and very similar to that in *A. versicolor*. Mandibles slender and not strongly curved, the teeth on the convex side large with bluntly rounded tips; those on the concave side slender and needle-like, longest at the point of the mandible, then growing rapidly smaller, and entirely disappearing at about the center of the side.

First maxillipeds large, the sucking disks being fully one-fifth the width of the carapace. This margin is supported in the usual manner by rods, which, instead of being made up of segments, as in most species, appear to be continuous and perfectly homogeneous.

Second maxillipeds stout and of the usual pattern, the basal joint armed with a triangular plate, which is broad and projects far behind the appendage. Its posterior margin is cut into three wide and blunt teeth, or, rather, laminæ, evenly rounded and very similar to those on *A. catostomi*. Nearly the entire ventral surface of the appendage is covered with spines and papillæ; the terminal claws are short and blunt.

Swimming legs of the usual pattern, the fourth pair with large boot-shaped posterior lobes, the toes of which project beyond the lateral margins of the abdomen.

The male is similar to the female, with the exception of the sex differentiations. The posterior lobes of the carapace are longer, as already stated, and just reach the anterior margin of the abdomen. The latter is relatively longer than in the female and narrower; the anal sinus does not extend to the center, and the tips of the posterior lobes are more bluntly rounded. The testes are long and narrow and situated close to the mid-line on either side.

The accessory sexual organs are in the form of broad laminate appendages, very prominent even in a superficial view. The two rami of the fourth legs are much widened, particularly the proximal joint of the endopod, whose posterior border is flattened into a broad lamina several times as wide as the terminal joint. At its base where it

joins the basipod it is enlarged posteriorly into a rounded lobe, whose surface is covered with rough papillæ. But the most prominent feature of these legs is the enormous lobe or lamina attached to the posterior margin of the basipod. This is boot-shaped, as in the female, but is fully twice as large, the toe of the boot being pointed, considerably widened, and turned forward so that it projects anteriorly in front of the exopod. The flap thus covers the whole of the endopod and about half of the exopod.

The basipod of the third legs is also furnished with broad laminate lobes, one along the posterior margin, which extends outward a little beyond the base of the endopod, and another on the ventral surface turned diagonally forward and outward.

The peg on the anterior margin of the basipod of the fourth legs and the semen receptacles on the posterior margin of the third legs are as in other species.

Female, total length 7.4 mm.; length of carapace 5.5 mm.; width of same 5.1 mm.; length of abdomen 1.8 mm.; width of same 1.6 mm.

Male, total length 8 mm.; length of carapace 5.9 mm.; width of same 5.4 mm.; length of abdomen 2.1 mm.; width of same 1.45 mm. Color (preserved material) a uniform creamy white with the dorsal surface sparsely covered with small spots of brown pigment.

There is a noticeable absence of pigment spots over the testes in the male and the ovary and semen receptacles in the female.

About twenty specimens of this new species, including both sexes, were obtained from a sucker (species not given) at Montpelier, Vermont, and were sent to the U. S. Bureau of Fisheries at Woods Hole in August, 1898. These have been made the types of the new species, and are numbered 32829 in the catalogue of the U. S. National Museum (*appendiculosus*, with many appendages, referring especially to the large laminate lobes on the posterior legs of the male, which look like extra appendages).

V. NOTES ON DEVELOPMENT.

On October 9, 1902, a paper was read before the South London Entomological and Natural History Society on "*Argulus foliaceus*, a Contribution to the Life History."

This was written by Frederick N. Clark, one of the vice-presidents of the society, and was published in their proceedings for 1902. It proves to be a valuable contribution and one which has not gained the prominence it deserves. This may be partly due to the fact that it is published in an entomological journal where one would not ordinarily look for important papers on the crustacea.

Several facts there published have an important bearing in connection with the present paper. The author writes on page 12:

> My observations commenced in 1896, since when I have had good opportunities of studying its life history, having repeatedly bred them from the egg to the adult stage, and so on again.

So far as known this is the only instance on record of the actual breeding of any parasitic copepod throughout its entire life history. The facts presented, therefore, are of special value since they are actual facts and not partial deductions.

On pages 19 and 20 are many interesting statements in reference to oviposition and the time required for hatching.

> Statistics which I have taken from twenty cases of oviposition show that the average time from the laying of the egg until hatching occupies 25 days.

It was found that temperature greatly influences the length of incubation, and that this period also varies still more widely for reasons which are apparently inexplicable. In testimony thereof witness the following:

> In confinement I have records of ova laid on November 29 and hatching on May 6 of the following year. On the other hand, some batches laid on August 30 and September 2 remained over the winter and hatched on April 10.

The former is a period of five months and eight days, the latter of seven months and two days either period being far in excess of any previously recorded. It must be remembered also that these were "in confinement" that is, in aquaria, where the temperature would be much higher than out of doors during these winter months.

The moral for the investigator would seem to be that if the eggs he is watching do not hatch within the allotted time he must still keep them, even to a period of six months; they may yet come around all right and hatch into normal larvæ at the eleventh hour.

Again, Clark states that eggs which began hatching on February 27 and continued into March "became adult on June 27, and laid ova which hatched on July 20 (twenty-three days.") In this case the entire period from the birth of the parents to the birth of the children was a week less than five months.

This enormous difference from an average of 25 days to a maximum of 212 days emphasizes more forcibly than ever before the necessity of keeping an accurate record of the attendant temperatures and conditions if we would form a rational conclusion in reference to the period of incubation. Fortunately the daily temperature of the water was carefully recorded during the incubation period of both of the larvæ here described, and is supplied in the account as given. It would be very interesting to determine what relation, if any, the length of the incubation period bears to the subsequent length of life of the Argulid. Would the continuance of the larvæ for 200 days within the egg tend to shorten its subsequent life?

Again Clark writes on page 20:

> The newly hatched Arguli immediately attach themselves to the fish, and only leave it to undergo their metamorphosis.

This is what would naturally be expected, for, in reviewing the development of the various families of parasitic copepods, we find that those larvæ which, like *Caligus*, *Ergasilus*, and the like, hatch into a typical nauplius form, remain free swimming through several nauplius and metanauplius stages before seeking their host.

On the contrary larvæ like those of *Chondracanthus*, *Achtheres*, etc., which pass the nauplius stage inside the egg, or moult from it as soon as they are hatched, remain free swimming but a very short time, seeking their host almost immediately.

In like manner these *Argulus* larvæ, which pass all the earlier stages inside the egg and hatch out in an advanced cyclops stage, seek their host immediately. It is no wonder that the efforts hitherto made to keep them through several moults without any host have all failed. But since they are not as particular about the species of host as many of their relatives, it ought to be easy in the future to supply some small and hardy fish to the newly hatched larvæ, that would serve as a temporary host and carry them through to the adult form. This suggestion bids fair to be of great value in future investigations not only of the Argulidæ, but of all the parasitic copepods.

Clark gives the average length of life of an Argulus as "probably over six months." In the opinion of the present author this ought to be lengthened somewhat, since adult Arguli have been repeatedly found, which had laid one batch of eggs, and another batch was beginning to form within the ovaries.

The prevalence of such specimens makes it probable that the normal female lays at least two batches of eggs. The formation and maturation of these eggs, in addition to the time required for the development of the larva to sexual maturity, almost certainly exceeds six months.

On page 21 it is stated that—

> If hungry or pressed for food the stickleback will sometimes swallow the Arguli, but generally speaking they are avoided, and if swallowed are ejected from the mouth.

This agrees fully with the experience of the present author as already recorded for the adults of *Argulus versicolor*[a], but the experience with the larvæ of *A. catostomi* given[b] in the same paper would suggest that some fish are in the habit of using these larvæ as a normal food supply.

Finally Clark records that *A. foliaceus* is frequently the victim "of a filamentous fungoid disease precisely similar in its nature to that of its

[a] Proc. U. S. Nat. Mus., XXV, p. 647. [b] Idem., p. 652.

host" (the stickleback). Without being able to prove their actual death as a result of the fungoid growth, many specimens of North American Arguli, of both the salt and fresh-water forms, have been obtained which showed the presence of such parasitic plants.

EXPLANATION OF PLATES.

PLATE XXIX.—The male of *Argulus catostomi.*

Fig. 1, dorsal view; fig. 2, first antenna; fig. 3, second antenna; fig. 4, second maxilliped; fig. 5, basipod of second swimming leg, dorsal view; fig. 6, basipod of third leg, ventral view; fig. 7, basipod of fourth leg, ventral view; fig. 8, testes and sperm receptacles; fig. 9, basipod of second leg, ventral view (turned from a horizontal to a vertical position), showing the appendage.

PLATE XXX.—The newly hatched larva of *Argulus funduli.*

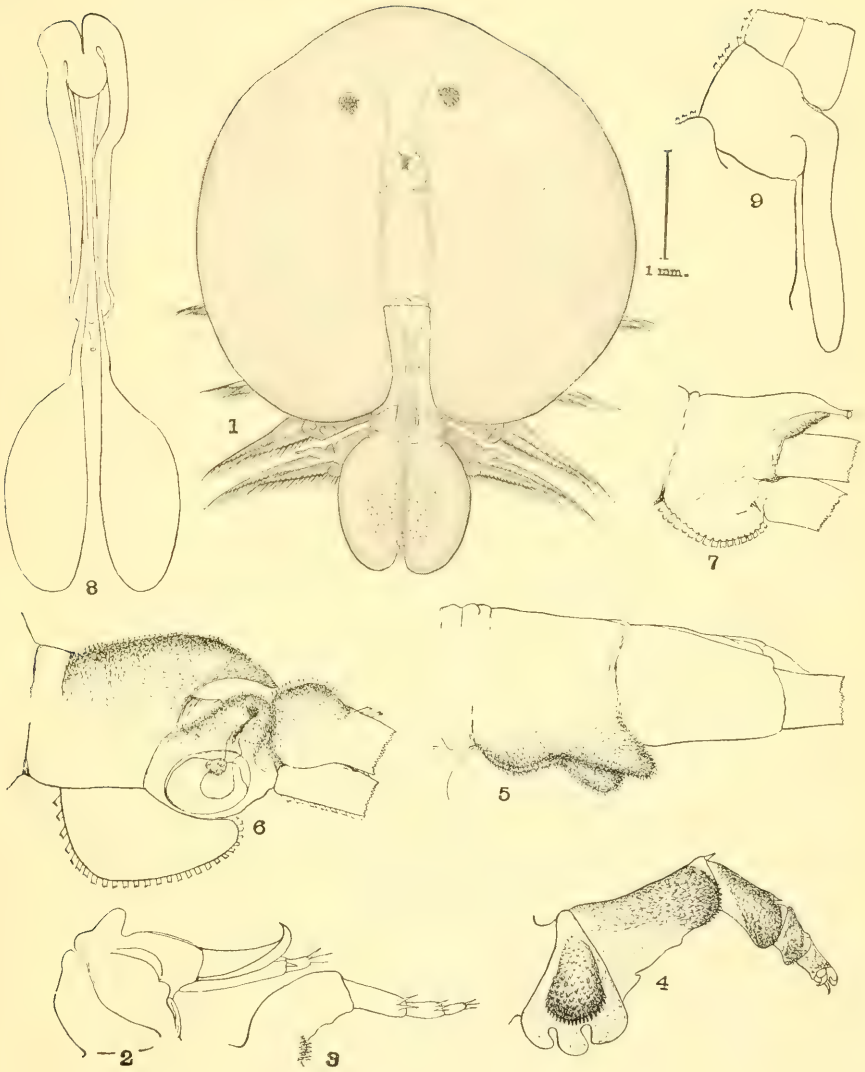
Fig. 10, dorsal view; fig. 11, first and second antenna; fig. 12, the mouth tube; fig. 13, first maxilliped; fig. 14, second maxilliped.

PLATE XXXI.—The newly hatched larva of *Argulus maculosus.*

Fig. 15, three freshly laid eggs, showing their arrangement and the form assumed by the jelly envelope; fig. 16, dorsal view of larva; fig. 17, first antenna; fig. 18, second antenna with temporary rowing apparatus; fig. 19, temporary mandibular palp at the base of the mouth tube; fig. 20, second maxilliped; fig. 21, first swimming leg; fig. 22, second, third, and fourth swimming legs.

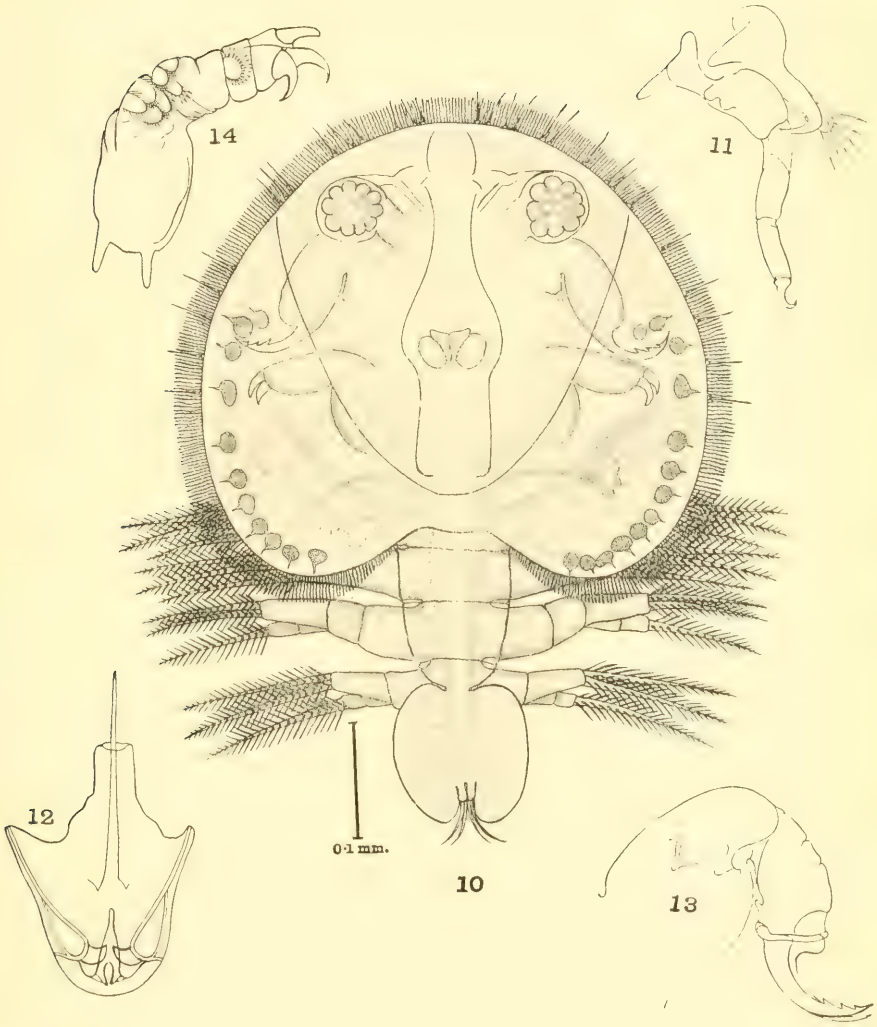
PLATE XXXII.—The male and female of *Argulus appendiculosus,* new species.

Fig. 23, dorsal view of female; fig. 24, dorsal view of male; fig. 25, first and second antennæ of female; fig. 26, mandible; fig. 27, second maxilliped; fig. 28, basipod of third leg of male; fig. 29, fourth leg of female; fig. 30, fourth leg of male, ventral view, showing the enormous boot-shaped appendage on the basipod.



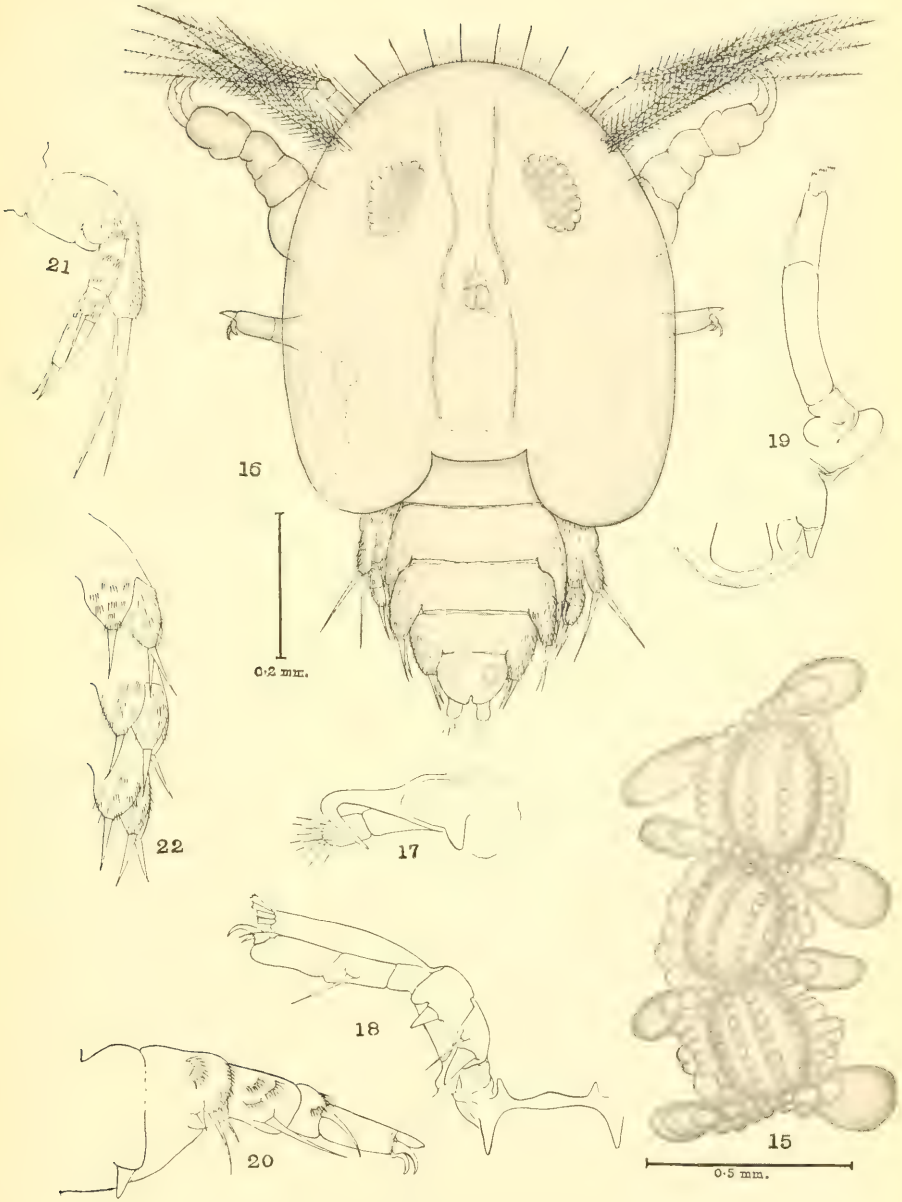
THE MALE OF ARGULUS CATOSTOMI.

FOR EXPLANATION OF PLATE SEE PAGE 424.



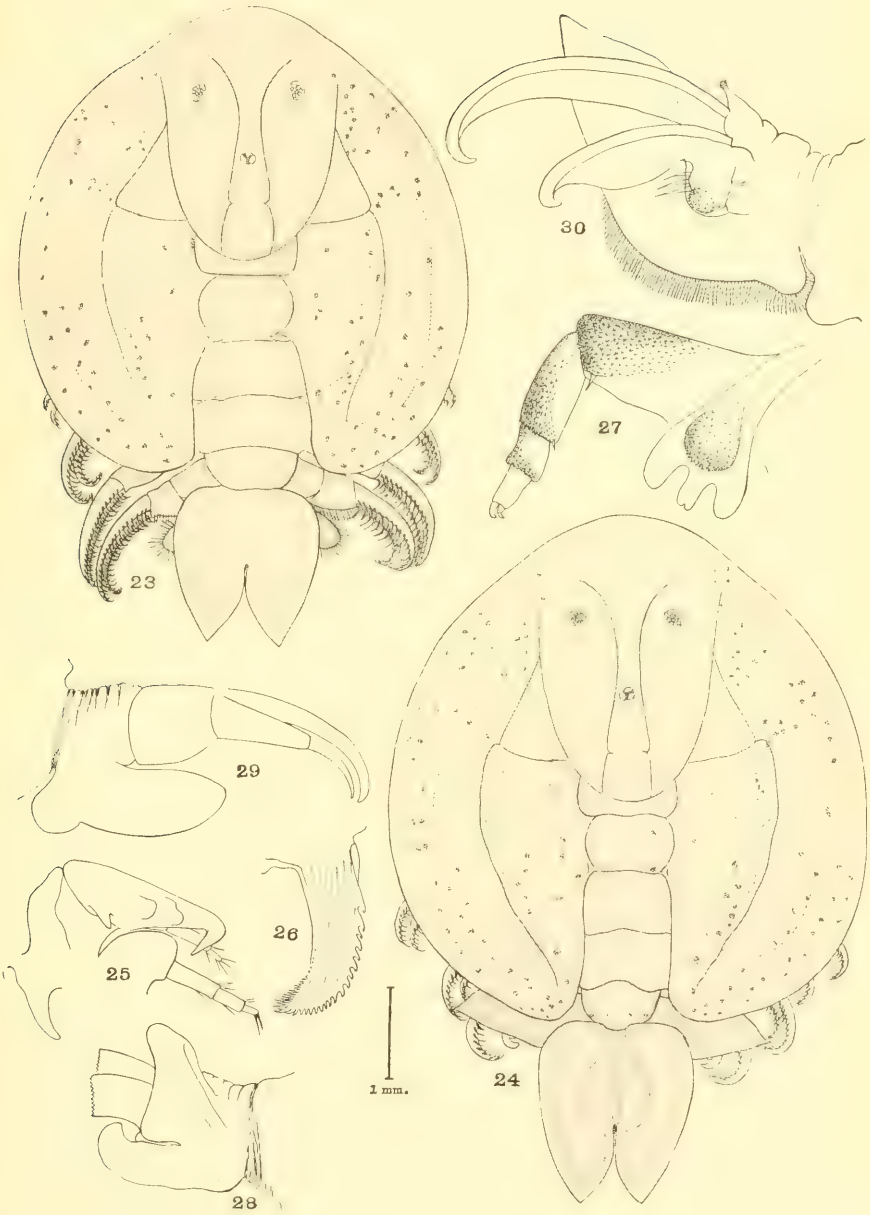
THE NEWLY HATCHED LARVA OF ARGULUS FUNDULI.

FOR EXPLANATION OF PLATE SEE PAGE 424.



THE NEWLY HATCHED LARVA OF ARGULUS MACULOSUS.

FOR EXPLANATION OF PLATE SEE PAGE 424.



THE MALE AND FEMALE OF ARGULUS APPENDICULOSUS.

FOR EXPLANATION OF PLATE SEE PAGE 424.

THE PŒCILIID FISHES OF RIO GRANDE DO SUL AND THE LA PLATA BASIN.

By Carl H. Eigenmann,

Of Indiana University, Bloomington, Indiana.

In a collection of Characins, belonging to the United States National Museum, there were found two specimens of a new Pœciliid from Paraguay. A determination of these made it necessary to look over the entire Pœciliid fauna of the La Plata basin. The results are presented in this paper.

Von Ihering has pointed out the general similarity between the fresh-water faunas of Rio Grande do Sul and the La Plata basin. The Pœciliids bear out his statement. All species recorded from Rio Grande do Sul have also been found in the La Plata basin, and are therefore included in the present paper.

The Pœciliids, better than any other fresh-water fishes, distinguish the Rio Grande do Sul-La Plata basins as a "province" distinct from the Amazonian on the north.

An examination of the teeth and male reproductive organs shows that several forms are generically distinct from their northern relatives. For instance, *Girardinus caudomaculatus* Hensel, which Garman[a] considers identical with *Glaridichthys januarius* (Hensel), proves to be generically distinct from *januarius*, and the latter is shown to be not a *Glaridichthys* but a new genus, unless it is identical with Garman's *Cnesterodon*.

The genera may be distinguished as follows (the extra limital relatives are in parentheses):

a. Teeth bicuspid.

(*b.* Several series of teeth..... *Characodon.*)

bb. Each jaw with a single series of bicuspid teeth; alimentary canal 3 times as long as the entire fish. D. 16–18; A. 14 or 15; scales small. Anal of male? *Ilyodon*, 1.

[a] The Cyprinodonts, p. 42.

aa. Teeth tricuspid.

(*c.* Teeth in a single series ..... *Cyprinodon* and *Jordanella.*)

cc. Each jaw with several series of tricuspid teeth, those of the outer row being much the largest; intromittent organ simple, the second of the elongated anal rays ending in a spine; no claspers; all the rays included in a loose membrane, graduated. Alimentary canal about equal to the entire length. D. 8 or 9; A. 9 or 10; lat. l. 29 ..... *Fitzroya*, 2.

aaa. Each jaw with two or more series of spear, oar, or spoon-shaped teeth, those of the outer series much the largest. D. 7–10; A. 9–12; lat. l. 28–31. Intromittent organ of those in this territory very long; formed by the third, fourth, and fifth rays, the posterior rays much shorter.

d. Intromittent organ without "claspers."

FIG. 1.—ACANTHOPHACELUS RETICULATUS, SHOWING COLOR VARIATION IN THE MALE.

(*e.* Intromittent organ short, with numerous recurved hooks on both margins; a prepuce (see figs. 1 and 2) ..... *Acanthophacelus.*)[a]

ee. Intromittent organ with the prolonged anal rays rolled up to form a tube; alimentary canal about twice the length of the fish ... *Phalloptychus*, 3.

eee. Intromittent organ "blade like," without hooks ..... *Cnesterodon*, 4.

dd. Anal not rolled up; tip of intromittent organ with claspers and without prepuce.

(*f.* Claspers consisting of three finger-like processes at tip of first prolonged ray of the anal (see figs. 3, 4, and 5).

Glaridichthys, Toxus, and *Girardinus.*)

[a] Type, *Pœcilia reticulatus* Peters. ἄκανθα, spine; φάκελος, bundle.

ff. Claspers consisting of antler-like processes at tip of second prolonged ray of the anal. Alimentary canal more than twice the entire length. *Phalloceros*, 5.

aaaa. Each jaw with bands of conical teeth; anal of male not modified.

g. Origin of dorsal in advance of anal. Anal 10–16; D. 9–18. Depressed forward. An air bladder ..... *Fundulus*, 6.

gg. Origin of dorsal behind that of anal.

h. A. 8–15; D. 6–11; lat. l. 29–44. Body subcylindrical. No air bladder ..... *Rivulus*, 7.

hh. Anal 20–29; D. 17–23; lat. l. 30–48. Head and body compressed. *Cynolebias*, 8.

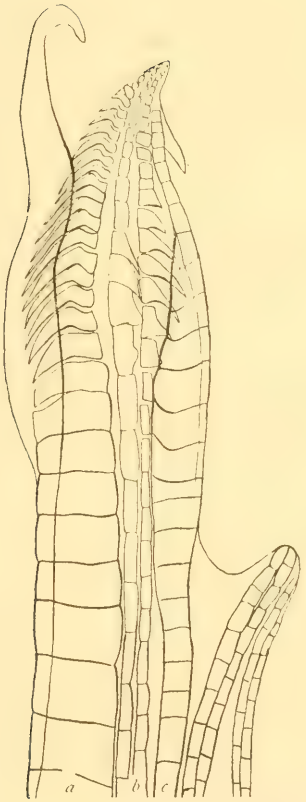


FIG. 2.—TIP OF INTROMITTENT ORGAN OF ACANTHOPHACELUS RETICULATUS. *a*, THIRD ANAL RAY, *b*, FOURTH ANAL RAY; *c*, FIFTH ANAL RAY.

FIG. 3.—TIP OF INTROMITTENT ORGAN OF GLARIDICHTHYS UNINOTATUS. *a*, THIRD ANAL RAY, *b*, FOURTH ANAL RAY; *c*, FIFTH ANAL RAY.

1. ILYODON[a] Eigenmann, new genus.

Intestine about 3 times as long as the body; dorsal and anal posterior. D. 16–18; A. 14 or 15; teeth bicuspid, in a single series; scales small.

[a] ἰλύς, ooze; ὄδους, tooth.

This genus appears to be allied to *Characodon*, from which it differs in having a much more elongate alimentary canal and a single series of teeth.

Type of genus.—*Ilyodon paraguayense*, new species.

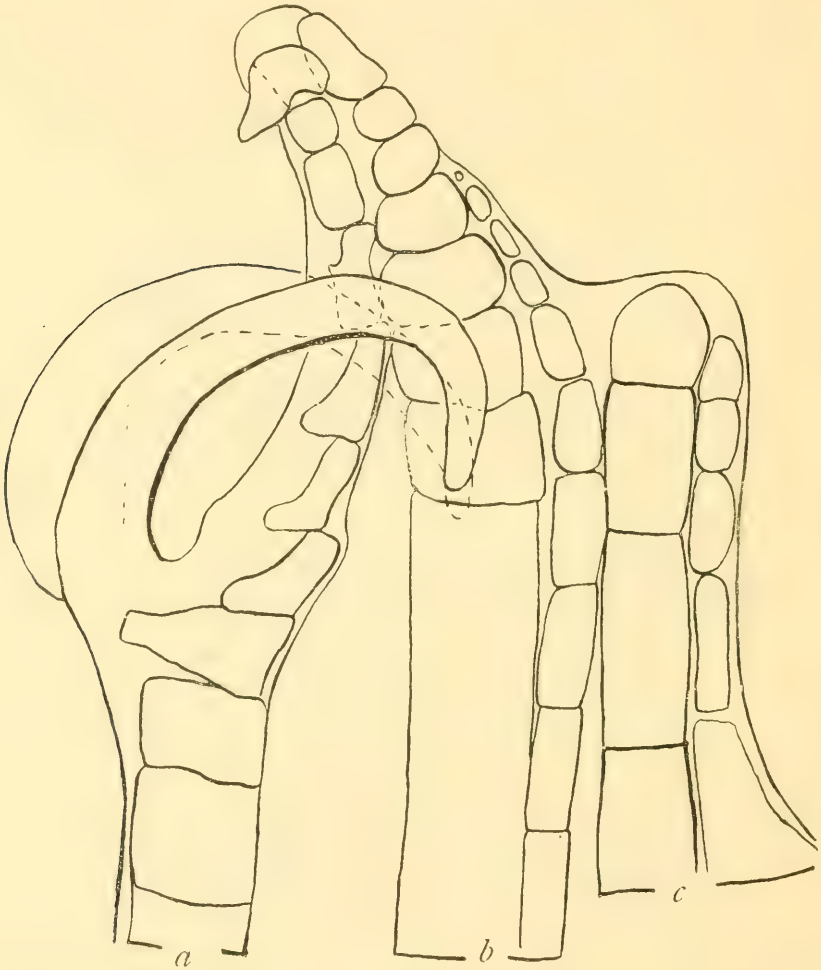


FIG. 4.—ENLARGED TIP OF THE INTROMITTENT ORGAN OF GLARIDICHTHYS UNINOTATUS. *a*, THIRD ANAL RAY; *b*, FOURTH ANAL RAY; *c*, FIFTH ANAL RAY.

1. ILYODON PARAGUAYENSE Eigenmann, new species.

Type.—Cat. No. 55642, U.S.N.M., a specimen 63 mm. long. Paraguay. E. Palmer.

Cotype 64½ mm. long. Paraguay. E. Palmer.

These two specimens were mixed in with some Characins. They are flattened out of shape as though they had been in a press.

D. 16–18; A. 14–15; scales about 45; head 4; depth probably about the same. Teeth close set, graduated, about 10 on each side of the

lower jaw, about 12 on each side of the upper. Eye a little more than 3 in the head. Origin of dorsal about equidistant from tip of snout to tip of caudal; origin of anal but little posterior to origin of dorsal; caudal slightly emarginate; anal basis less than half the dorsal basis. Pectorals reaching $\frac{2}{3}$ to ventrals, about $1\frac{1}{2}$ in head; height of anal $2\frac{1}{2}$ in head. Dorsal, caudal, and anal with conspicuous subterminal black bands, the tips hyaline; middle and base of caudal dusky; base of anal hyaline, or with a second dark band; base of dorsal dusky; pectorals and ventrals colorless.

FIG. 5.—DISTAL PARTS OF THE INTROMITTENT ORGAN OF GIRARDINUS METALLICUS. *a*, THIRD ANAL RAY; *b*, FOURTH ANAL RAY, *c*, FIFTH ANAL RAY.

2. FITZROYA Günther.[a]

Fitzroya GÜNTHER, Cat. Fishes Brit. Mus., VI, 1866, pp. 299, 307 (*multidentata*).
Jenynsia GÜNTHER, Cat. Fishes Brit. Mus., VI, 1866, pp. 300, 331 (*lineata*).

Type of genus.—*Lebias multidentata* Jenyns.

[a] *Fitzroya multidentata* has several series of tricuspid teeth. *Jenynsia lineata* is said to have but a single series. Garman considers the species identical.

2. FITZROYA LINEATA Jenyns.

Habitat.—Rio Grande do Sul; Montevideo and Maldonado to the Province Salta, Argentina.

3. PHALLOPTYCHUS[a] Eigenmann, new genus.

An outer series of spoon-oar shaped teeth and bands of much smaller teeth behind them.

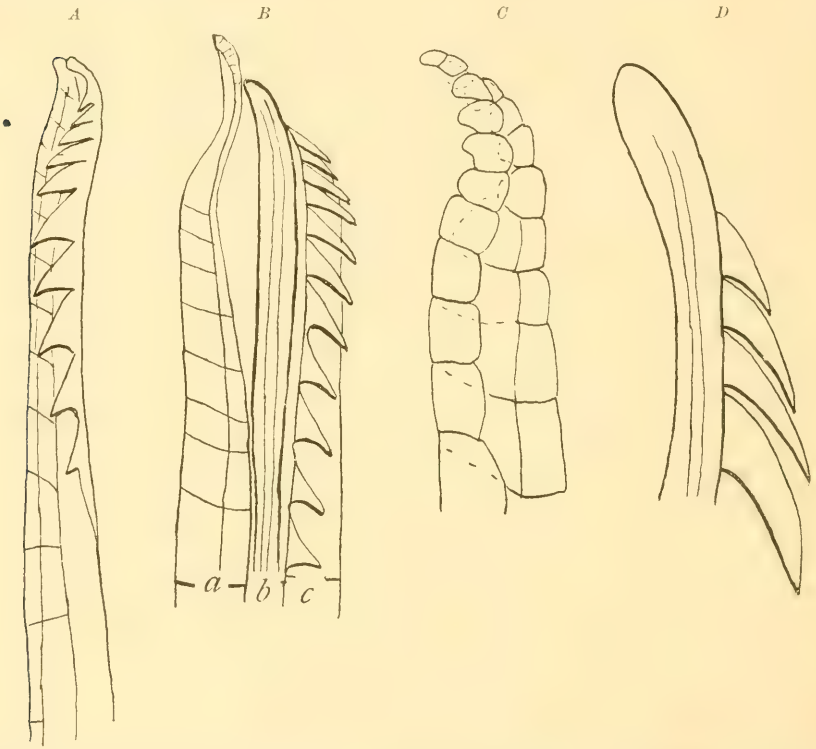


FIG. 6.—DISTAL PARTS OF THE INTROMITTENT ORGAN OF PHALLOPTYCHUS JANUARIUS. *A*, THE ORGAN AS IT IS NORMALLY FOUND; *B*, UNFOLDED; (*a*, THIRD ANAL RAY; *b*, FOURTH ANAL RAY; *c*, FIFTH ANAL RAY). *C*, THIRD ANAL RAY, ¾ VIEW; *D*, FIFTH ANAL RAY, ENLARGED.

First and second anal ray of the male minute, the third, fourth, and fifth much prolonged. The anterior part of the third ray folded back, the fifth, and part of the fourth folded forward, forming a slender tube at tips; no claspers, the organ ending in a simple point; third ray without hooks or spines, fourth with very strong, retrorse hooks behind these being turned forward in the folded organ. (See fig. 6.)

Intestine about twice length of fish.

Type of genus.—*Girardinus januarius* Hensel.

[a] φαλλός intromittent organ, πτύσσω (πτυξ) to fold.

3. PHALLOPTYCHUS JANUARIUS (Hensel).

Habitat.—Southeastern Brazil to Maldonado and Paraguay.

4. CNESTERODON Garman.

Cnesterodon GARMAN, The Cyprinodonts, 1895, p. 43, pl. v, fig. 13, and pl. VIII, fig. 16. (*decemmaculatus.*)

4. CNESTERODON DECEMMACULATUS (Jenyns).

Habitat.—Rio Grande do Sul to Maldonado and Bolivian Chaco.

5. PHALLOCEROS[a] Eigenmann, new genus.

Each jaw with an outer series of spoon-oar-shaped teeth, somewhat expanded at tip and bent backward, close set, their margins in contact near their tips; much smaller teeth, triangular at tips, slightly contracted at base, forming one or more series behind the larger teeth.

Anal in the males inserted about midway in length of body, the first two rays minute, the third, fourth, and fifth united, of nearly equal length and separated by a slight notch from the remainder of the fin, which is very low; the third ray (*a*) much the heaviest; fourth ray (*b*) ending in an antrorse point, and with two large, antler-like structures just below; a series of retrorse hooks on its posterior face protected by the fifth ray (*c*).

Intestine about twice as long as the entire fish; dorsal in female slightly posterior to insertion of anal.

Type of genus.—*Girardinus caudomaculatus* Hensel.

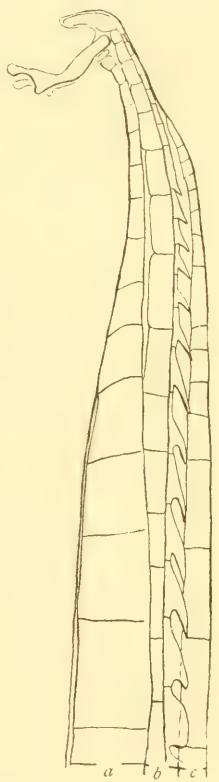


FIG. 7.—DISTAL PARTS OF THE INTROMITTENT ORGANS OF PHALLOCEROS CAUDOMACULATUS. *a*, THIRD ANAL RAY; *b*, FOURTH ANAL RAY; *c*, FIFTH ANAL RAY.

5. PHALLOCEROS CAUDOMACULATUS (Hensel).

Habitat.—Rio Grande do Sul to Paraguay.

Paraguay specimens have the dentaries firmly joined; teeth of outer row moderately expanded, the inner, smaller teeth in rather broad bands on the sides; in a single series or much narrower band in the middle.

In Rio Grande do Sul specimens the smaller teeth form a single series mesially, and imperfectly two series laterally. (See fig. 7.)

[a] φαλλός, intromittent organ; κέρας, horn.

6. FUNDULUS Lacépède.[a]

6. FUNDULUS BALZANII (Perugia).

Habitat.—Villa Maria (Matto Grosso), Rio Paraguay.

7. FUNDULUS PARAGUAYENSIS[b] Eigenmann and Kennedy.

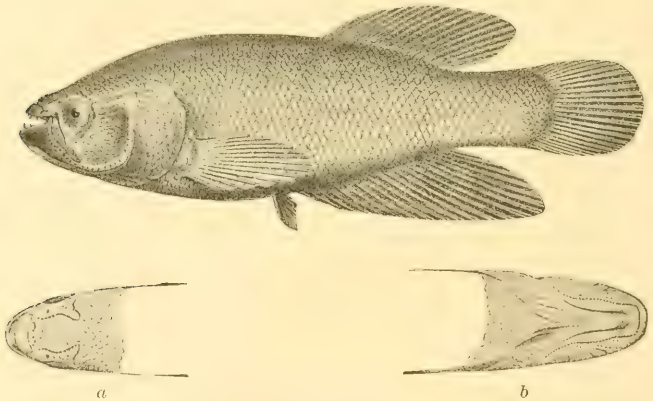
Habitat.—Arroyo Trementina, Paraguay. (See fig. 8.)

FIG. 8.—FUNDULUS PARAGUAYENSIS, TYPE.

7. RIVULUS Poey.

8. RIVULUS PUNCTATUS Boulenger.

Habitat.—Colonia Risso, near the Rio Apa.



a *b*

FIG. 9.—CYNOLEBIAS POROSUS, TYPE. *a*, HEAD FROM ABOVE; *b*, HEAD FROM BENEATH.

8. CYNOLEBIAS Steindachner.

Cynolebias STEINDACHNER, Ichthyol. Beitr., p. 124, pl. x, fig. 3. (*porosus.*)

Type of genus.—*Cynolebias porosus* Steindachner. (See fig. 9.)

[a] I am not certain that these species belong to the genus *Fundulus.*

[b] It is possible that this species may prove to be a synonym of *balzanii.* They differ as follows:

* D., 9; A., 14; scales, 4–34–5; depth, 4; head, 3; eye, 3 in head; caudal plane; dorsal and anal with three series of spots.....*balzanii*

* D. 10; A. 12; lat. l., 34; depth, 4; head, 3½; eye, 3½ in head; caudal with numerous crossbars; dorsal and anal, with four dark longitudinal bands.
paraguayensis

9. CYNOLEBIAS BELLOTTII Steindachner.

Habitat.—La Plata. (See fig. 10.)

FIG. 10.—CYNOLEBIAS BELLOTTII. *a*, HEAD OF SAME.

10. CYNOLEBIAS ELONGATUS Steindachner.

Habitat.—La Plata.

11. CYNOLEBIAS MACULATUS Steindachner.

Habitat.—La Plata. (See fig. 11.)

FIG. 11.—CYNOLEBIAS MACULATUS.

12. CYNOLEBIAS ROBUSTUS Günther.

Habitat.—La Plata.

A REVIEW OF THE COBITOID FISHES OF THE BASIN OF THE AMUR.

By Leo Berg,

Of the Zoological Museum of the Imperial Academy of Sciences, Saint Petersburg.

This paper contains a review of the Cobitidæ known to inhabit the water system of the Amur River. It is based on material belonging to the Zoological Museum of the Imperial Academy of Sciences at St. Petersburg and duplicates in the United States National Museum.

1. MISGURNUS FOSSILIS ANGUILLICAUDATUS (Cantor).

Cobitis fossilis Georgi, Reise, I, 1775, p. 354 ("Nertschinskische Flüsse.")
Cobitis anguillicaudatus Cantor, Ann. Mag. Nat. Hist., IX, 1842, p. 485 (Chusan).
Cobitis decemcirrosus Basilewsky, Mém. Soc. Nat. Moscou, X, 1855, p. 239 (Peking).
Cobitis fossilis var. *mohoity* Dybowski, Verh. zool.-bot. Gesell. Wien, XIX, 1869, p. 957 (Onon, Ingoda).
Misgurnus fossilis Warpachowski, Vestn. Rybopr. (Russian), VII, 1892, p. 153 (Khanka Lake, No. 8414).
Misgurnus anguillicaudatus Jordan and Fowler, Proc. U. S. Nat. Mus., XXVI, 1903, p. 766 (Japan, Formosa; contains full synonymy).
Misgurnus decemcirrosus Jordan and Snyder, Proc. U. S. Nat. Mus., XXX, 1906, p. 833 (N. E. China) and *M. anguillicaudatus* (Japan, S. E. China, Chusan, Shanghai).
Ussuria leptocephala Nikolsky, Ann. Mus. Zool. Pétersb., VIII, 1903, p. 362 (Ussuri, Kerulen; Nos. 10655, 12791).

After comparing *M. anguillicaudatus* from East Asia with specimens of *M. fossilis* from Europe (see table), I became convinced that they are closely allied (as noticed already by Doctor Günther.)[a] The only obvious distinguishing character is the color: in European and West Siberian specimens there are on the sides of the body longitudinal bands, while in east Asiatic specimens the bands are substituted by irregularly distributed dark spots. Some specimens from Amur, as regards the color, are intermediate between *anguillicaudatus* and *fossilis*. As the plastic characters are identical in both species, I regard *anguillicaudatus* as a subspecies of *fossilis*.

[a] Cat. Fish., VIII, 1868, p. 345.

This subspecies varies much more than the European form, especially as regards the length of pectorals; the width and depth of body are also subject to much variation.

In a recent paper[a] Messrs. Jordan and Snyder have referred specimens from northeastern China to *M. decemcirrosus* Basilewsky, and indicated that they differ from *anguillicaudatus* as follows:

a. Scales relatively large, about 112 (105 to 118) in a lateral series; body plump, the depth $6\frac{1}{3}$ to $6\frac{2}{3}$ in body; head $6\frac{1}{4}$ to $7\frac{1}{3}$ in length; barbels long, the longest $1\frac{3}{4}$ to $2\frac{2}{3}$ in head; eye, 2 to 3 in snout; color, relatively plain, the stripes and spots not very distinct. Streams of northeastern China ..... *decemcirrosus.*

aa. Scales relatively small, about 148 (143 to 154) in lateral series; body slender, the depth $6\frac{2}{3}$ to 8 in length; head, $6\frac{1}{3}$ to $6\frac{1}{4}$ in length; barbels short, the longest $3\frac{1}{4}$ to $4\frac{1}{3}$ in head; eye, $2\frac{2}{3}$ to 3 in snout; coloration rather brighter, but very variable; the body with dark lateral shades and more or less numerous small black spots. Streams of Japan, common everywhere in Hondo, Shikoku, and Kiusiu; also in southeastern China, Chusan, Shanghai, etc. *anguillicaudatus.*

The examination of a large collection of *M. anguillicaudatus* from Amur, China, and Japan, belonging to our museum, convinced me that *decemcirrosus* is a nominal species. If we regard the specimens from near Peking as a distinct species, we shall be obliged to regard many varieties of the same species found in other parts of China and in Japan also as distinct species, which is inadmissible in consequence of the known variability of *anguillicaudatus.*

Concerning the scales, I am unable to find any differences between the Japanese and north Chinese specimens. In Nos. 2341 and 8640 from Peking, I count 145 scales, in No. 8640 from Pikua (Kansu), 150, in specimens from Japan, 155–170. Also in *M. fossilis* the number of scales in the lateral line is subject to much variation. In specimens from Europe I find 165–175 scales, while Valenciennes[b] gives 135–140. As regards the depth of the body I find in Japanese 6.3–9.1, (in body without caudal) in north Chinese, 6.7–7.2, in specimens from Amur, 6.8–9.0; length of head is respectively 6.4–6.8, 6.1–6.2, 6.8–7.8; eye in snout, 2.2–2.6, 2.3–2.4, 2.0–4.4, etc. Both in China and Japan there are specimens that are plain as well as brightly colored. Most convincing to me was a comparison between No. 4280 from Japan (Doctor Schlegel's collection) and No. 2341 from Peking; they belong to a variety with high body and differ in no respect one from another; scales, color, as plastic characters, are quite identical. On the other hand, bright colored specimens from Nagasaki (No. 7515) are identical with similarly colored specimens from the Amur Basin (No. 12791).

[a] Proc. U. S. Nat. Mus., XXX, 1906, p. 833.

[b] Cuvier and Valenciennes, XVIII, 1846, p. 48.

Measurements.	*M. fossilis.*		*Misgurnus fossilis anguilli caudatus.*									
	Basel, No. 2417.	Dnieper, No. 10144.	Lake Khanka, No. 8414.	Do.	Sungari, No. 13703.	Ussuri, No. 10655.	Peking, No. 2341.	Pikua Kansu, No. 8640.	Nagasaki, No. 7515.	Do.	Nagasaki, No. 8439.	Japan, No. 4280.
Total length in mm	182	168	135	134	197	143	194	147	156	137	117	141
Length of body without caudal (*l*)	155	145	117	116	170	125	165	123	136	120	100	121
Lateral line	170	175	165	170	.....	.....	145	150	155	.....	.....	170
Depth of body in length (*l*)	7.0	7.6	9.0	8.6	6.8	8.6	6.7	7.2	9.1	8.0	7.5	6.4
Length of head in (*l*)	6.7	6.2	7.3	6.8	6.6	7.8	6.2	6.1	6.8	6.7	6.4	6.7
Length of barbel in head	2.62	2.61	2.66	2.61	3.40	2.66	3.12	3.47	2.96	3.00	2.58	3.00
Eye in snout	3.0	4.0	2.0	3.1	4.4	2.4	2.4	2.3	2.3	2.2	2.6	2.3
Width of body in (*l*)	9.7	10.8	11.7	11.0	8.9	13.1	9.2	8.0	13.3	11.8	10.0	9.3
Length of pectoral in (*l*)	8.6	9.1	6.6	8.3	11.3	10.4	9.1	8.0	10.8	10.9	5.7	10.1
Length of caudal peduncle in (*l*)	5.7	5.5	6.2	6.1	6.8	5.5	5.9	6.5	6.5	5.0	5.7	5.5

The genus *Ussuria* established by M. Nikolsky is based on an error. *Ussuria* is described as having only 8 cirri (2 on the mandible), otherwise as in *Misgurnus;* but after examining the type specimens No. 10655 and No. 12791 I find in both 10 cirri (4 on the mandible), otherwise these specimens are quite identical with *M. fossilis anguillicaudatus.*

We have many specimens from the basin of Amur: basin of Khanka or Haupa Lake (No. 8414), Ussuri at Khabarovsk (No. 10655), Kerulén River (tributary of Argun; No. 12791); Da-chu-ang, tributary of Sungari (No. 13703), from China; Peking, Pikua in Kansu, Hui-hsien in S. Kansu, from Japan.

LEFUA Herzenstein.

Octonema Herzenstein, Trud. Soc. Natur. Petersburg, XIX, 1887, p. 47 (*pleskei=costata;* name preoccupied).

Lefua Herzenstein, Przewalski's Fische, 1888, p. 91 (*pleskei=costata*).

Elixis Jordan and Fowler, Proc. U. S. Nat. Mus., XXVI, 1903, p. 768 (*nikkonis*).

Cirri 8, four rostral, two maxillary and two at the anterior nostrils. Scales present. No erectile spine below the eye. Dorsal fin about over the ventral, with few rays; caudal rounded. Air bladder with a posterior part free in the abdominal cavity. Two species: *L. costata* in the basin of Amur, N. China, and Korea; *L. nikkonis* in N. Japan.

2. LEFUA COSTATA (Kessler).

Diplophysa costata Kessler in Przewalski, Mongolia, and the Land of Tanguts, II, 1876, Fishes, p. 29, pl. III, fig. 3 (Dalai-nor Lake, inner basin of E. Mongolia, No. 2477).

Octonema pleskei Herzenstein, Trud. Soc. Nat., Petersburg, XIX, 1887, p. 48, fig. 5 (Khanka Lake, No. 7209).

Lefua costata Herzenstein, Przewalski's Fische, 1888, p. 93 (No. 2477).

Lefua pleskei Herzenstein, Przewalski's Fische, 1888, p. 95 (No. 7209).

Nemachilus dixoni FOWLER, Proc. Acad. Nat. Sci., Phila. 1899, 1900, p. 181 (Tan-lan-ho, near Dolon-noor, trib. of Liao-ho).

Elixis coreanus JORDAN and STARKS, Proc. U. S. Nat. Mus., XXVIII, 1905, p. 201, fig. 7 (Gensan, Fusan).

We have specimens from Dalai-nor Lake (No. 2477), Ulugui River (in Khinghan mountains), Khanka Lake (Ussuri River), Da-chu-ang (tributary of Sungari), Vladivostok (in a rivulet), numerous specimens in Gensan (Korea, No. 13723).

3. NEMACHEILUS BARBATULUS TONI (Dybowski.)

Cobitis toni DYBOWSKI, Verh. zool.-bot. Gesell. Wien, XIX, 1869, p. 957, pl. XVIII, fig. 10 (system of Amur; Onon, Ingoda); Verh. zool.-bot. Gesell. Wien, XXIV, 1874, p. 392 (system of Baikal; Angara, Selenga, Kossogol L.).

?*Nemachilus compressirostris* WARPACHOWSKI, Ann. Mus. Zool. Pétersb., II, 1897, p. 270 (a lake in N. W. Mongolia, basin of Ob).

Nemachilus pechiliensis FOWLER, Proc. Acad. Nat. Sci. Phila., (1899) 1900, p. 181 (Liao-ho).

Nemachilus toni BERG, Ann. Mus. Zool. Petersb., V, 1900, p. 362, pl. VIII, fig. 10 (Baikal; basin of Selenga).

Orthrias oreas JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXVI, 1903, p. 769, fig. 2 (Japan; Chitose in Iburi, Hokkaido).

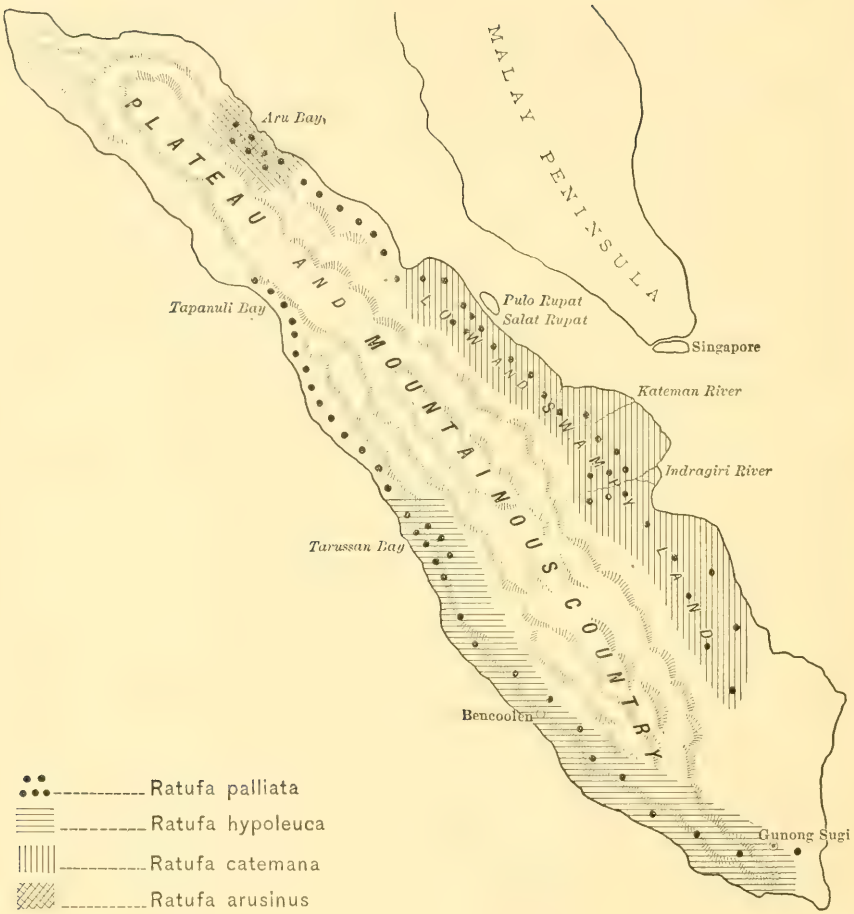
Nemacheilus barbatulus toni BERG, Trav. Section Troitkoz-Kiakhta Soc. Russ. Geogr., VIII, No. 3, (1905) 1906 p. 66 (Kossogol Lake, Baikal Lake, basin of Amur, Sakhalin).

The loach from East Asia differs very slightly from the common *N. barbatulus* from Europe and W. Siberia, as is proved in my above-mentioned Russian paper, where measurements may be found. The genus *Orthrias* Jordan and Fowler differs from *Nemacheilus* van Hasselt only in having the caudal fin truncate instead of forked. This character is scarcely of generic value, as in some central Asiatic *Nemacheilus* the caudal fin in young specimens is emarginated, while in adult ones it becomes truncate. We have specimens from the Khanka Lake (No. 8485), Argun River (No. 3205), and mouth of Amur (No. 13828), also numerous specimens from the Baikal Lake, Kossogol Lake, Ob River.

4. COBITIS TÆNIA Linnæus.

There are no differences between the specimens from the Amur River and *C. tænia* from Europe and Japan. *C. sinensis* Sauvage, judging from one specimen from Pung-tung (Korea), seems to be a distinct subspecies, *C. tænia sinensis*, differing from typical *tænia* by its lateral blotches, being very high, narrow, and extending far below the lateral line.

C. tænia is widely distributed through the Amur basin. We have specimens from Argun River, Albasin, Khingham, Khanka Lake, Ussuri River, mouth of Amur.



MAP OF SUMATRA SHOWING PROVISIONAL DISTRIBUTION OF GIANT SQUIRRELS.

REMARKS ON THE GIANT SQUIRRELS OF SUMATRA, WITH DESCRIPTIONS OF TWO NEW SPECIES.

By Marcus Ward Lyon, Jr.,
Assistant Curator, Division of Mammals, U. S. National Museum.

The U. S. National Museum has in its collections 49 specimens of giant squirrels, genus *Ratufa,* from various parts of the island of Sumatra, all but two of which have been collected and presented by Dr. W. L. Abbott. I have also had at my disposal three specimens of Sumatran *Ratufa* belonging to the collection of the Academy of Natural Sciences of Philadelphia. To Mr. Witmer Stone of that institution my thanks are due for the use of them.

The giant squirrels on Sumatra fall into two distinct groups, representatives of which are found side by side in the same localities. Members of the *palliata* or *bicolor* group are known by their larger size, as well as by their dark heads, necks, shoulders, rumps, legs, and feet. Only one form of this group is at present known to occur on Sumatra. The *hypoleuca* group, so called from the first species described from Sumatra, contains smaller members than the other group, with white or buffy underparts, and with uniformly light brownish upper parts. Three well-marked forms of this group are found on Sumatra—typical *hypoleuca* on the west coast, and two new species on the east coast. (See map, Plate XXXIII.) All the forms of Sumatra giant squirrels may be readily known by the following key and descriptions:

SYNOPSIS AND KEY TO THE GIANT SQUIRRELS OF SUMATRA.

A. Upper surface of head, neck, shoulders, arms, legs, and feet black or blackish brown, different in color from the sides and rest of upper parts.
Ratufa palliata, p. 440.

A′. Entire upper parts and sides uniform light yellowish brown, sometimes becoming darker along the middle line of the lower back.

B. Underparts white or whitish, feet concolor with legs, size large; head and body, 340 to 370 mm.; tail, 400 to 435; hind foot with claws, 79 to 84; greatest length of skull, 65 to 67.....*Ratufa hypoleuca*, p. 441.

B′. Underparts buff to ochraceous buff, feet not concolor with legs, but in general a dark blackish brown, often lined with some ochraceous buff hairs; size large; head and body, 335 to 355 mm.; tail, 390 to 445; hind foot with claws, 81 to 84; greatest length of skull, 64 to 67 ..... *Ratufa arusinus*, p. 442.

B″. Underparts buffy, feet concolor with legs, size small; head and body, 310 to 330 mm.; tail, 370 to 390; hind foot with claws, 73 to 78; greatest length of skull, 60 to 63 ..... *Ratufa catemana*, p. 443.

RATUFA PALLIATA Miller.

1902. *Ratufa palliata* MILLER, Proc. Acad. Nat. Sci. Phila., March ,1902, p. 147; issued June 11, 1902.

Type.—Adult male, skin and skull, Cat. No. 113162 U.S.N.M., collected along the Indragiri River, southeastern Sumatra, September 23, 1901, by Dr. W. L. Abbott. Original number, 1327.

Diagnostic characters.—Very similar to *Ratufa bicolor* from Java, but hind foot apparently larger; upper parts without the light speckling usually seen in *R. bicolor*, and tail never appearing clear buff, but an indefinite mixture of dark brownish and buffy, often appearing annulated. The light yellowish brown mantle mentioned in the original description as characteristic, while often present is not found to be a constant feature in all the examples of this species that have been collected by Doctor Abbott since the original account of the species appeared.

Color.—Upper surface of head and neck, shoulders and rump, and outer surface of fore and hind legs and fore and hind feet, blackish or dark brown; color of back between shoulders and rump, variable; in the type and some other specimens, dark cream-buff, becoming clay-color in the middle line, while in other individuals the middle line of the back has the general effect of Ridgway's seal brown, generally blending with the cream-buff color of the sides. Sides of head and neck, shoulders, and sides of body, as well as inner side of foreleg and a spot just above wrist, cream color, or cream-buff, and, except on the sides, contrasting with the black of the head, neck, etc. Underparts and inner side of hind legs generally cream-buff, but the dark bases of the hairs show to a considerable extent. Hairs of the tail, blackish-brown, lighter at the base, with a broad (6 mm.) subterminal cream or cream-buff ring and an inconspicuous brownish apex. The two colors of the tail are about equally prominent, and usually so arranged as to give the tail a somewhat annulated appearance.

A very young individual, Cat. No. 114547 U.S.N.M., from Tapanuli Bay, evidently in its first pelage, long and soft, deviates somewhat from the color pattern just described. The mantle is well developed, varying between a light clay color and ochraceous buff; the black of the head, neck, rump, and thigh is largely replaced by a color between hazel and chestnut; this color extends on the base of the tail, above, and is again indicated at the tip of the tail; the middle

portion of the tail is distinctly annulated. Cat. No. 141052, U.S.N.M., a nearly adult male from Tarussan Bay, is in general similar to Cat. No. 114597, U.S.N.M., but the mantle is darker and the reddish brown less conspicous. Eight of the specimens have the light colored mantle well-marked, while in the remaining 13 it is practically absent. In certain skins, the mantle seems to be the result of a bleaching of the hairs as the pelage becomes old, but its presence in the two immature individuals shows that it may be found in fresh pelages. The pelage of the type is also apparently fresh. When the pelage is old, the hairs of the back, either uniformly or in irregular patches, assume a dull, dirty russet color; the tail assumes this color throughout and loses all traces of annulation, the light subapical bands of the hairs having nearly all worn off, and the tips of the hairs having a curled and singed appearance.

Skull and teeth.—The skull and teeth of *Ratufa palliata* are large and heavy, and are as easily distinguished on this account from those of the *hypoleuca* group as are the skins. The differences between skulls of *R. palliata* and *R. bicolor* are slight. The material at hand shows the Sumatran species to have shorter rostrum, nasals, and audital bullæ, and the zygomatic width somewhat greater.

Measurements.—See page 445.

Specimens examined.—Twenty-two; 9 from Aru Bay, 2 from Salat Rupat, 1 from the Indragiri River, 6 from Tarussan Bay, 1 from Tapanuli Bay, 1 from Gunong Sugi, and 2 simply marked "Sumatra."

Remarks.—*Ratufa palliata* is apparently uniformly distributed over the island of Sumatra. (See map, Plate XXXIII.) Specimens from various localities agree in all essential respects with the type, but it is a matter of regret that the species is not represented by a good series from the type locality.

RATUFA HYPOLEUCA (Horsfield.)

1824. *Sciurus hypoleucos* Horsfield, Zoological Researches in Java (pages not numbered).

Type. In the British Museum, collected by Sir Stamford Raffles, and hence probably from Bencoolen on the west coast of Sumatra. I have not seen the type of this species, nor specimens from the type locality. The following description is based on specimens from the vicinity of Tarussan Bay on the west coast of Sumatra, which agree in all respects with Horsfield's description of the species.

Diagnostic characters.—Upper parts uniform light brown, underparts white, feet concolor with legs; size large.

Color.—Middle line of back from behind shoulders to base of tail brown, not identical with any color in Ridgway's "Nomenclature of Colors," but nearest a dark Vandyke or Prout's brown; not contrasted with rest of upper parts; top of head and neck from behind

eyes, sides of neck and body, upper part of thighs, and upper part of forearm a grizzle of russet and dark brown, the former color more conspicuous; underparts, inner side of legs, sides of head and region about nose, inner side of ear and spot on thigh, white or nearly so; lower leg and arm a rather bright russet, and feet dull russet; tail seen from above concolor with lower back, seen from below whitish in the middle line, but at tip and margin same color as it is above. There is a marked contrast in color between the sides and underparts. Bordering the white underparts, the russet of the sides forms a bright and clear line, with scarcely any admixture of brown. The fringes on the fore and hind legs are bright clear russet. In worn pelage, the upper parts become dull wood-brown or clay-color. Similar changes take place in the tail.

Skull and teeth.—The skull and teeth of *Ratufa hypoleuca* show no special characters; they are large like those of the form from Aru Bay, and much smaller than those of *R. palliata.*

Measurements.—See page 445.

Specimens examined.—Seven from Tarussan Bay and two from Gunong Sugi.

Remarks.—*Ratufa hypoleuca* is probably confined to the western side and highlands of Sumatra, while in the swamp lands of the east side it is replaced by a related form, and in the northern portion of the island still another form of it occurs. (See map, Plate XXXIII.)

RATUFA ARUSINUS, new species.

Type.—Adult male, skin and skull, Cat. No. 143351 U.S.N.M., collected at Aru Bay, northeast coast of Sumatra, January 16, 1906, by Dr. W. L. Abbott. Original number, 4635.

Diagnostic characters.—Similar to *Ratufa hypoleuca,* but underparts dark buff, instead of white; fore and hind feet dark brown, instead of concolor with legs; and white markings about the head less conspicuous.

Color.—Upper parts of head, neck, and body, sides of body, and outer sides of forelegs a fine grizzle of a color between buff and raw sienna, and one similar to Prout's brown, the former color in excess anteriorly and on the sides, the latter in excess posteriorly in the middle line. Entire underparts, inner and outer sides of hind legs, inner side of forelegs, and fringe on outside dark buff or ochraceous buff. Spot on thigh cream-buff or whitish. Fore and hind feet a very dark mummy brown, containing here and there a few scattered raw sienna hairs. Cheeks and small area about the mouth dirty whitish, irregularly lined with some light and dark brownish hairs. The whitened area on the head is much less extensive than it is in *R. hypoleuca* and is not found on the forehead between the eyes. Tail seen from above a very dark brown, similar to Ridgway's seal brown; below, the outer

margin and tip is the same, followed by an irregular line of the color of the underparts of body, while centrally it is irregularly cream-buff; the short-haired portion in the middle line is a mixture of ochraceous buff and blackish brown. In worn pelages the brown of the upper parts of body becomes lighter and duller, and the grizzling is less conspicuous; the brown of the tail becomes much lighter.

Skull and teeth.—These show no special characters, and it is apparently impossible to distinguish skulls of *Ratufa arusinus* from skulls of *R. hypoleuca.*

Measurements.—*Ratufa arusinus* closely agrees with *R. hypoleuca* in size. See page 445.

Specimens examined.—Thirteen from the vicinity of Aru Bay, northeastern Sumatra.

Remarks.—While clearly related to *Ratufa hypoleuca*, *R. arusinus* possesses several well-marked characters, such as light upper parts, dark buff underparts, brown feet, and less white about the head, by which it may be differentiated from the former. At present it is known only from the vicinity of Aru Bay. Possibly it may have a distribution similar to that of *Sciurus vittatus albescens* and be found to occur throughout the northern end of Sumatra.

RATUFA CATEMANA, new species.

1902. *Ratufa hypoleuca* Miller, Proc. Acad. Nat. Sci. Phila., March, 1902, p. 149; issued June 11, 1902. Indragiri River specimens.

Type.—Adult male, skin and skull, Cat. No. 123124, U.S.N.M., collected along the Kateman River, southeastern Sumatra, August 27, 1903, by Dr. W. L. Abbott. Original number, 2759.

Diagnostic characters.—Similar to *Ratufa hypoleuca*, but much smaller, upper parts lighter, under parts usually buff instead of white, and white about head much less conspicuous.

Color.—The colors of *Ratufa catemana* are rather difficult to describe. The specimens were collected in August and September and appear to be in old and worn pelage, not comparable with the pelage of the species described above. Top of head and neck, upper parts and sides of body, and upper surface of tail have the general effect of Ridgway's broccoli or wood brown. Where there is an indication of fresh pelage, especially along the sides, the color seems to be similar to that of *Ratufa arusinus.* The fore and hind feet and outer surfaces of legs and sides of body bordering the light underparts are tawny, with a slight amount of dark-brown grizzling on the feet and arms. The underparts vary from whitish (especially in the Indragiri River skins) to a dark buff or ochraceous buff. The tail, above, is generally a dull brown, similar to Ridgway's wood or broccoli brown. A young example, Cat. No. 123125, U.S.N.M., shows indistinct annulations on the tail. The outer edge and the tip of the tail seen from

below are colored as they are above, the basal portion of the hairs is light buffy and the middle portion ochraceous buffy. The short appressed hairs underneath are mummy brown, with some ochraceous buff hairs intermingled. Sides of head, white or buffy; cheeks and nose, ochraceous buff, with some dark brown grizzling. Thigh spot, buffy.

Skull and teeth.—These show no special characters, except for their smaller size.

Measurements.—See page 445.

Specimens examined.—Three from Indragiri River; five from Kateman River.

Remarks.—From its geographical position, *Ratufa catemana* is naturally associated with *R. hypoleuca* and *R. arusinus*, but its resemblance in point of size and coloration to *R. affinis* of Singapore and the Malay Peninsula is very striking. It differs from *R. affinis* principally in having much darker upper parts, more white about the head, and in having the feet concolor with the legs. Mr. Miller, in his paper on Doctor Abbott's Indragiri River collection, pointed out that this giant squirrel might be different from *Ratufa hypoleuca* of the west coast. The Sumatran giant squirrels of the *hypoleuca* group show in differentiation a striking analogy to the squirrels of the *Sciurus vittatus* group,[a] in which the form inhabiting the lowlands of south-eastern Sumatra is indistinguishable from that on the Malay Peninsula; in which specimens from northern Sumatra differ from those taken elsewhere on the island and in which the Tarussan Bay form differs from east coast varieties. Whether the three forms of the *hypoleuca* group are subspecies of one species it is impossible to say. The material at present shows them to be very different, so that no specimen in any one of the three series can be mistaken for any specimen in another of the series.

[a] See Lyon, Smithsonian Miscell. Coll., XLVIII, p. 277, Feb. 4, 1907.

Measurements of giant squirrels from Sumatra.

Name.	Locality.	Number.	Sex.	Head and body.[a]	Tail.[a]	Hind foot with claws.[b]	Greatest length of skull.	Zygomatic breadth.	Interorbital constriction.	Maxillary tooth row (alveoli).
				mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
R. hypoleuca	Tarussan Bay	141040	Male adult	355	430	80	66.4	40.5	26	13
Do	do	141041	do	365	435	79	66.2	41	26.8	13.7
Do	do	141042	Female adult	340	410	84	64.5	41	26.1	13.1
Do	do	141043	Male adult	347	430	83	66.6	40.5	26.3	12.9
Do	do	141044	do	350	400	79	.....	.....	26	12.5
Do	do	141045	do	370	430	84	64.6	39.9	25.8	12.9
Do	do	141046	do	350	410	82	65.8	41.8	25.2	13.3
Do	Gunong Sugi	[c]6657	Female adult	.....	.....	83	64	.....	25.8	12.5
Do	do	[c]6658	Male adult	.....	.....	81	65.9	37.9	25.3	12.8
R. catemana	Indragiri River	113163	do	330	375	76	62	39.4	26.2	12.4
Do	do	113164	do	320	380	77	61.1	.....	25.5	12.1
Do	do	113165	Female adult	330	370	79	5[illegible].6	37.2	24.4	11.7
Do	Kateman River	123123	Male adult	310	370	77	61	37.4	24.6	11.4
Do	do	[d]123124	do	320	385	74	61.9	38.5	24.6	12.3
Do	do	123125	Male immature	275	380	73	57.7	35.8	23.8	11.2
Do	do	123126	Female adult	310	375	75	60.5	38.3	25.4	12.1
Do	do	123127	do	325	380	78	62.3	39.3	25.6	11.9
R. arusinus	Aru Bay	143346	Male young adult	345	405	81	63.7	37.8	24	12.7
Do	do	143347	Male adult	335	420	82	64	38.7	25.9	12.5
Do	do	143348	Female adult	355	400	81	66.6	42.5	27	13
Do	do	143349	Male adult	350	400	81.5	64.2	40.4	25.8	12.7
Do	do	143350	do	355	365	84	64	38.9	23.7	12.7
Do	do	[d]143351	do	354	405	81.5	65.9	40.8	25.7	12.6
Do	do	143352	do	350	400	80	66	40	25.7	12.2
Do	do	143353	do	350	440	82	67	41.1	26.8	12.3
Do	do	143354	Female adult	310	370	82	67	40	25.8	12.8
Do	do	143355	Female young adult.	310	405	83	62.7	37.7	23.7	12.8
Do	do	143356	Female adult	340	450	84	65.8	39.3	25	12.8
Do	do	143357	do	340	465	83.5	66.1	39.9	26.5	12.1
Do	do	143358	do	350	445	83.5	65.1	41.8	26.8	12.4
R. palliata	do	143359	Male adult	368	472	88	71.9	44.6	29.1	13.7
Do	do	143360	do	350	452	83	69.7	41.7	27	13.7
Do	do	143361	do	360	440	84	69.6	45	28.8	13.3
Do	do	143362	do	370	460	81	69.3	41.9	26.8	13.4
Do	do	143363	do	.....	460	85	69.3	43.1	28.9	13.5
Do	do	143364	Female adult	390	455	90	72.4	44	27.3	14.3
Do	do	143365	do	375	480	86	73.7	44	28.4	14.7
Do	do	143366	do	370	455	85	70.6	45	28.9	14.3
Do	do	143367	do	355	460	84	71.2	44.3	28.2	14.8
Do	Salat Rupat	143368	Male adult	360	433	83	70.2	44.7	27.9	13.1
Do	do	143369	Female adult	365	435	86	70.5	45.8	29.3	13
Do	Indragiri River	[d]113162	Male adult	345	425	83.5	68.2	42.5	28.8	13
Do	Gunong Sugi	[c]6656	Adult	.....	.....	81	68.6	44.4	27.9	13.4
Do	"Sumatra"	114003	Male adult	.....	.....	80	66.5	41.7	26.4	14.4
Do	do	114004	Female adult	.....	.....	80	67.8	41.1	27	14.1
Do	Tarussan Bay	141047	do	380	470	90	72.6	46.7	28.3	14.5
Do	do	141048	do	352	455	86	71	45.7	30.3	14.2
Do	do	141049	Male adult	360	455	86	.....	.....	.....	.....
Do	do	141050	Female adult	380	460	85	72.3	47.2	31	14
Do	do	141051	do	398	476	86.5	72	46.2	29.5	13.4
Do	do	141052	Male immature	360	440	85	68.8	42	27.8	14.2
Do	Tapanuli Bay	114547	Female immature	270	370	82	59.6	34.6	22.5	13.6

[a] Collector's measurements.
[b] Measured by writer after relaxing feet in water for 48 hours.
[c] Coll. Acad. Nat. Sci. Phila.
[d] Type.

A NEW TERRESTRIAL ISOPOD FROM GUATEMALA, THE TYPE OF A NEW GENUS.

By Harriet Richardson,

Collaborator, Division of Marine Invertebrates, U. S. National Museum.

The following description is of a new isopod which was collected by Messrs. E. A. Schwarz and H. S. Barber, in the spring of 1906, at Livingston, Guatemala, and is now deposited in the United States National Museum. The single specimen found is the type of a new genus.

Family ARMADILLIDIDÆ.

SPHERARMADILLO, new genus.

Description.—Head margined in front. Frontal margin straight. Epistome with a slight shield-like convexity. Flagellum of second pair of antennæ composed of three articles. Eyes absent.

First thoracic segment with the epimera or coxopodites on the underside, extending almost the entire length of the lateral margin in the form of a wide band, not reaching the posterior margin of the segment and being cleft posteriorly by a rather deep fissure. The position and form of the coxopodite gives the lateral margin of the segment a thickened appearance. The epimera or coxopodites are not present on any of the following segments.

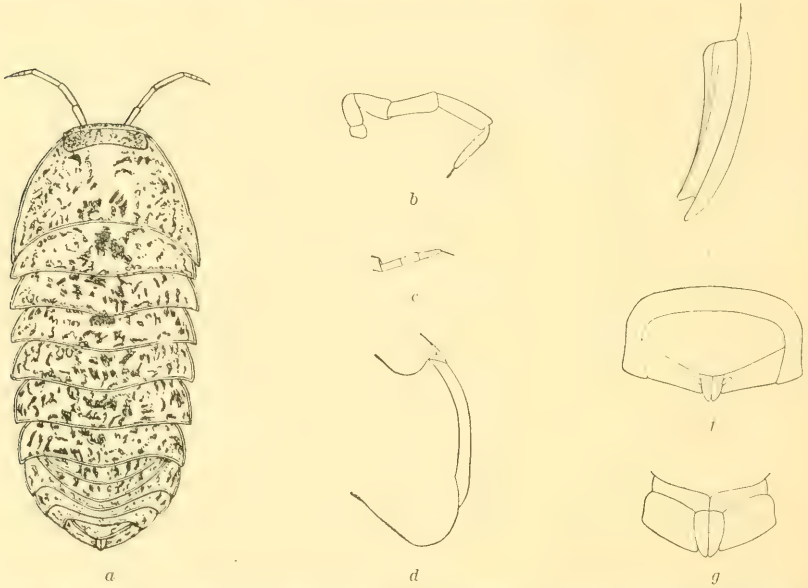
The terminal abdominal segment is triangular, with the apex obtusely rounded. The basal article of the uropoda is quadrangular, broader than long, not reaching beyond the lateral parts of the fifth abdominal segment, but extending considerably beyond the apex of the terminal abdominal segment. The inner branch extends considerably beyond the apex of the sixth abdominal segment and reaches a little beyond the inner post-lateral angle of the basal article of the uropoda. The outer branch is inserted in a notch about the middle of the inner lateral margin of the basal article and occupies a lateral position.

Type of genus.—Spherarmadillo schwarzi.

SPHERARMADILLO SCHWARZI, new species.

Description.—Body convex, contractile into a ball, a little more than twice as long as wide, 50 mm. by 22 mm. Color yellow, with numerous arborescent markings of dark brown.

Head much wider than long, 3 mm. by 10 mm. with the front straight and margined. The epistome has a slight shield-like convexity. There is no trace of eyes. The first pair of antennæ are rudimentary and inconspicuous. The second pair have the first article small; the second is about twice as long as the first; the third is equal



SPHERARMADILLO SCHWARZI, *a*, DORSAL VIEW, X 3; *b*, SECOND ANTENNA, X 7; *c*, FLAGELLUM OF SECOND ANTENNA, X 7; *d*, LATERAL PART OF FIRST THORACIC SEGMENT (LATERAL VIEW), X 7; *e*, LATERAL PART OF FIRST THORACIC SEGMENT (VENTRAL VIEW), X 7; *f*, LAST TWO SEGMENTS OF ABDOMEN WITH UROPODA, X 7; *g*, UROPODA (VENTRAL VIEW), X 7.

in length to the second; the fourth is one and a half times as long as the third; the fifth is a little longer than the fourth. The flagellum is composed of three articles, the middle one of which is slightly shorter than either of the others, which are subequal.

The first thoracic segment is nearly twice as long as any of the following segments which are subequal. The first segment is 9 mm. in length. Each of the following is about 5 mm. long. The lateral parts of the first segment are slightly produced backward in rounded lobes. Epimera or coxopodites are present on the underside and extend in the form of a wide band along the entire lateral margin almost to the posterior margin and are cleft posteriorly by a rather deep fissure. The form and position of the coxopodites give a thick-

ened appearance to the lateral margin. Epimera are not present on any of the following thoracic segments.

The first segment of the abdomen is the longest, being 3 mm. in length. The two following segments are subequal and each is 2 mm. long. The next two segments, the fourth and fifth, are subequal and each is 1.5 mm. in length. The first two segments are covered laterally by the seventh thoracic segment. The sixth or terminal segment is triangular in shape. It is 9 mm. wide at the base and 4 mm. long in the median longitudinal line. The apex is obtusely rounded. The basal article of the uropoda occupies all the space between the terminal segment of the abdomen and the produced lateral parts of the fifth segment. It does not extend beyond the lateral parts of the fifth segment, but extends considerably beyond the apex of the triangular terminal segment. In shape it is quadrangular, broader than long, with the inner anterior part covered by the apical portion of the terminal abdominal segment. The inner branch of the uropoda extends considerably beyond the apex of the terminal abdominal segment and a little beyond the inner post-lateral angle of the basal article. The outer branch is inserted in a deep notch about the middle of the inner lateral margin of the basal article. This branch lies in a lateral position.

All the legs are ambulatory.

The type and only specimen was collected at Livingston, Guatemala, by Messrs. E. A. Schwarz and H. S. Barber, in April, 1906, and is in the U. S. National Museum. Cat. No. 33471.

This genus is perhaps more closely related to *Sphæroniscus* Gerstæcker than to any other genus of the Armadillididæ, these two being the only genera of that family in which the flagellum of the second antennæ is composed of three articles. *Spherarmadillo schwarzi* more closely resembles *Sphæroniscus portoricensis* Richardson[a] than the other species of that genus in the shape of the terminal abdominal segment, the basal article of the uropoda, and the form and position of the inner branch. It differs, however, from that species in the absence of eyes, the presence of distinct coxopodites on the underside of the first thoracic segment, and in the form and position of the outer branch of the uropoda. This branch is inserted in a notch in the middle of the inner lateral margin of the basal article, and it is this character which distinguishes it from all the species belonging to the genus *Sphæroniscus*.

This genus also resembles *Synarmadillo* Dollfus[b] in the form of the

[a] Proc. U. S. National Museum, XXIII, 1901, p. 573; Bull. U. S. National Museum, No. 54, 1905, pp. 662–663.

[b] Ann. Soc. Entomologique de France, LXI, 1892, pp. 388–389, pl. VII, fig. 4.

terminal segment of the abdomen, the shape of the basal article of the uropoda, and the form and position of the inner branch. It differs, however, from that genus in having three articles instead of two to the flagellum of the second antennæ, in the form and position of the outer branch of the uropoda, which is inserted in a notch about the middle of the inner lateral margin of the basal article instead of at the inner post-lateral angle of that article as in *Synarmadillo*. The terminal abdominal segment is also shorter than in *Synarmadillo*, exposing more of the inner branches of the uropoda.

This species is named after Mr. E. A. Schwarz, custodian of Coleoptera in the U. S. National Museum, who collected the specimen.

A REVIEW OF THE SPECIES OF THE TEN-SPINED STICKLEBACKS OR PYGOSTEUS FROM EAST ASIA.

By Leo Berg,

Of the Zoological Museum of the Imperial Academy of Sciences, Saint Petersburg.

In the present paper a review of the species of *Pygosteus* (Family Gasterosteidæ) known to inhabit the waters of East Asia and Japan is given. It is based on material in the Zoological Museum of the Imperial Academy of Sciences in St. Petersburg and specimens in the U. S. National Museum.

1. PYGOSTEUS PUNGITIUS (Linnæus).

Gasteracanthus pungitius Pallas, Zoogr. Rosso-Asiat., III, 1811, p. 228 (Kamchatka, sea of Okhotsk).

Gasterosteus pungitius brachypoda Bean, Proc. U. S. Nat. Mus., IV (1881), 1882, p. 240 (Alaska).

Gasterosteus pungitius Nikolsky, Mem. Acad. Sci., Petersburg, LX, 1889, sup. No. 5, p. 292 (Sakhalin, river Tym, No. 6592, Siska).

Gasterosteus pungitius Herzenstein and Warpachowski, Trud. Soc. Nat. Petersburg, XIX, 1887, p. 16 (Amur, at Kalgho; No. 2362 ex parte, another specimen=*P. sinensis*).

Pygosteus pungitius Jordan and Gilbert, Fish. Bering Sea, 1899, p. 444 (Petropaulski Harbor, lake near Tareinsky Bay).

We have specimens from mouths of the Yana River (No. 10204 coll. Bunge); Kolyma River, Verkhne-Kolymsk (Nos. 10410, 10072 coll., Czerski); Sea of Okhotsk (No. 4393 coll., Middendorff), Ajan (Sea of Okhotsk, No. 2384 coll., Wosnessensky); west coast of Kamchatka (No. 2385 coll., Wosnessensky); Avacha Bay (Petropaulski, Kamchatka, No. 2362 coll., Schrenck); Alaska (No. 2402 coll., Russ.-Amer. Company); Sitka (No. 2390 coll., Wosnessensky); Amur River at Kalgho (No. 2363 coll., Schrenck); Tym River and Siska River in Sakhalin (No. 6591–2, 6588 coll., Poljakow); Japan, Hakodate (No. 2367 coll., Maximovicz). Messrs. Jordan and Starks[a] do not indicate this species for Japan. Japanese specimens differ in no respect from European. A circumpolar species: I have seen *P. pungitius* from Khatanga, Pechora, Archangelsk, Lapland.

[a] Proc. U. S. Nat. Mus., XXVI, 1902, p. 61.

2. PYGOSTEUS TYMENSIS (Nikolsky).

Gasterosteus tymensis NIKOLSKY, Mem. Acad. Sci. Petersburg, LX, 1889, p. 293 (Sakhalin Island, Tymi River, Nos. 6593–5).

Pygosteus undecimalis JORDAN and STARKS, Proc. U. S. Nat. Mus., XXVI, 1902, p. 62, fig. (Chitose in Hokkaido).

Our specimens from Sakhalin (Nos. 6593–6595) differ in no respect from the Japanese. Dorsal spines XI–XII. This species differs from *P. pungitius* in having very short dorsal and ventral spines and a much feebler keel on the caudal peduncle. The exterior processes of the pubic bone are only slightly developed. As remarks Nikolsky[a] *P. tymensis* is allied to an "abnormal variety of *P. pungitius*," described by F. Day[b] from Ireland as having a badly marked keel on the side of the tail, and ventral spines lacking or very small.

3. PYGOSTEUS SINENSIS (Guichenot).

Gasterosteus sinensis GUICHENOT, Nouv. Arch. Mus. Hist. Nat. Paris, V, 1869, p. 204, pl. XII, fig. 4 (China, Yang-tse-Kiang? a small specimen, 35 mm.).—SAUVAGE, Nouv. Arch. Mus. Hist. Nat. Paris, X, 1874, p. 33 (same specimen).

Gasterosteus japonicus STEINDACHNER, Sitzber. Ac. Wien, mat.-nat. Cl., LXXXII, 1880, p. 264, pl. III, fig. 2 (Gulf of Strielok, near Vladivostok).

Gasterosteus bussei WARPACHOWSKI in Herzenstein and L. Warpachowski, Trud. Soc. Natur. Petersburg, XIX, 1887, pp. 13, 54, fig. 1 (Lefu River, tributary of Khanka Lake, basin of Amur; No. 7100).

Pygosteus steindachneri JORDAN and SYNDER, Proc. U. S. Nat. Mus., XXVII, 1901, p. 747, after Steindachner.—JORDAN and STARKS, Proc. U. S. Nat. Mus., XXVI, 1902, p. 61 (Tokyo, Aomori, Yamashiro).

Pygosteus sinensis JORDAN and STARKS, Proc. U. S. Nat. Mus., XXVIII, 1905, p. 203 (Gensan).

We have specimens from Lefu River, a tributary of Khanka Lake (No. 7100 coll., Pleske), from Ussuri (No. 13761 coll., Paltschewsky), Da-chu-ang, tributary of Sungari (No. 13799 coll., Mjachkow), Gulf of Ussuri, near Vladivostok (No. 13800 coll., Paltschewsky), Amur River at Kalgho (No. 2363*a* coll., Schrenk). Hakodate (No. 2368 coll., Maximovicz). This species differs from *P. pungitius* only in having the sides of the body mailed; but the more recently described *P. sinensis wossnessenskyi* from Kamchatka with very reduced lateral armature connects *P. sinensis* with *P. pungitius*. More abundant material would permit us, I think, to accept *P. sinensis* as a mailed variety of *P. pungitius*. The form of the lateral processes of the pubic bone is subject to much variation even in specimens from the same locality. The length of the dorsal and ventral spines depends on the age of the individual; in adults, spines are shorter while in young ones they are longer (see table).

[a] Mem. Acad. Sci. Petersburg, LX, 1889, p. 293.

[b] F. Day, Fishes of Great Britain and Ireland, I, 1880–84, p. 245, pl. LXVIII, fig. 4.

PYGOSTEUS SINENSIS STENURUS (Kessler).

Gasterosteus stenurus KESSLER in Przewalski, Mongolia, and the land of Tanguts, 1876, Fishes, p. 6, pl. III, fig. 6 (Dalai-nor, 43° N.).

We have specimens from Lake Dalai-nor in E. Mongolia (No. 2471 type-specimens) which differ from *P. sinensis* in having a more slender body. The depth of the body is contained 6 times in the total length without caudal, while in *sinensis* 5–5½. The lateral armature is usually but little developed, the shields being small.

PYGOSTEUS SINENSIS WOSSNESSENSKYI (Kessler).

Gasterosteus wossnessenskyi KESSLER, in Przewalski, Mongolia, and the land of Tanguts, 1876, p. 9 (west coast of Kamchatka; Nos. 2377–8).

We have specimens from Kamchatka (No. 2377–8 coll., Wossnessensky). The lateral armature is much less developed, even in the anterior part of body frequently wanting. Length to 90 mm.

Name and locality.	Number of dorsal spines.	Total length of body with caudal (mm.).	Total length of body without caudal (*length*).	Depth of body in length.	Length of head in length.	Length of eye in mm.	Length of middle dorsal spine in mm.	Length of ventral spine in mm.	Length of ventral spine in the length of head.
Pygosteus pungitius.									
Onega L. (N. Russia)	X	58½	51	5.1	3.6	4	3	6	2.33
Hakodate	IX	59	52	5.2	3.7	4	3	6	2.33
Ajan (Sea of Okhotsk)	XI	61	54	4.7	3.8	4¼	3	6	2.33
Alaska	XI	89	79	4.9	4.3	4	3½	6	3.01
P. sinensis.									
Khanka L. (Amur R.)	IX	60½	54½	5.4	4.4	3¼	2½	6	2.01
Vladivostok	IX	77	70	5.3	4.7	4	2⅔	6	2.01
Ussuri R.	IX	41	36	4.8	3.6	3	3	5⅓	1.74
Sungari R.	VIII	38½	34	5.2	4.0	2½	2½	4½	1.88
Hakodate	IX	50	44	4.9	3.7	3¾	2¼	4⅓	2.52
P. sinensis stenurus.									
Dalai-nor (Mongolia)	IX	61½	55	6.1	3.9	4	3	5	2.80
	IX	55	49	6.1	4.1	3½	2¼	5¼	2.18
P. sinensis wossnessenskyi.									
Kamchatka	IX	70	63	5.0	3.7	4½	3	5⅔	2.96
	IX	87	70	6.1	4.1	5	4	6	3.16
P. tymensis.									
Sakhalin	XII	60	52	5.0	3.5	5	1	2	7.5

The following is a synopsis of the known Eurasiatic species of *Pygosteus:*

a. Caudal peduncle laterally with a well developed keel.

b. Anterior part of body naked, without bony plates.

c. Lateral [exterior, upper] processes of the pubic bone well developed, ventral spine long, 1¾–3 in head; dorsal spines high. Circumpolar.....*P. pungitius.*

cc. Lateral processes of the pubic bone almost wanting, ventral spine short, 5–7½ in head; dorsal spines very low. Sakhalin, N. Japan ..... *P. tymensis.*

bb. Anterior part of body with vertical bony plates.

d. Plates well developed, depth of body 4½–5⅓ in total length (without caudal). Amur, Vladivostok, Japan, Korea, China (Yang-tse-kiang?) ..... *P. sinensis.*

dd. Plates less developed, depth of body 6 in total length (without caudal). Dalai-nor Lake in E. Mongolia ..... *P. sinensis stenurus.*

ddd. Plates less developed, sometimes on the anterior part of the body interrupted or wanting. Kamchatka ..... *P. sinensis wossnessenskyi.*

aa. Caudal peduncle smooth, laterally without keel.

e. Anterior part of body naked. France, England ..... *P. lævis.*

ee. Anterior part of body more or less protected with vertical bony plates. Many varieties in Black, Caspian, and Aral seas ..... *P. platygaster.*[a]

---

[a] *Gasterosteus platygaster* Kessler, Bull. Soc. Nat. Moscou, XXXII, 1859, Pt. 2, p. 202 (Odessa, mouth of Dnieper.)

NOTES ON MAMMALS OF THE KANKAKEE VALLEY.

By Walter L. Hahn,
Fellow in Zoology, Indiana University, Bloomington, Indiana.

During the month of August, 1905, the writer was engaged in field work for the United States National Museum in the Kankakee basin in northwestern Indiana. Most of the time was spent in trapping small mammals and the results of this collecting, together with the information obtained from trappers and other residents of the region, are embodied in the present paper.

The region is one of considerable interest to the naturalist. In a general way it marks the eastern limit of several species of mammals which are characteristic of the prairies, and in zonal position it is also intermediate, having elements of both the Transition and Upper Austral life zones. The large areas of almost impenetrable swamp have furnished retreats for many of the larger animals so that some of them have survived here longer than in most other localities in Indiana or the adjoining States. At the present time, however, the land is being drained and reduced to cultivation and the effect of such extensive changes as are being caused by these processes afford opportunities for a closer study of problems in local adaptation than the writer was able to make in the limited time at his disposal.

According to the official report of a survey made in 1882, the reclaimable swamp land of the Kankakee Valley in Indiana at that time comprised an area of 500,000 acres. A part of this was permanently under water, while the remainder was flooded only during periods of heavy rainfall. Most of the area was covered with a dense growth of coarse marsh grass and reeds and was treeless, but a heavy growth of timber of varying width lined the banks of the river. Low sand hills, rising above the level of the marsh, formed islands, which were generally wooded and which afforded homes for nonaquatic plants and animals.

Since 1882 much of the land has been drained. English Lake, represented on maps still in general use as the largest lake in the State, no longer exists. Beaver Lake, a large body of water in Newton County, has been drained and its former site is now under cultivation. At other localities also marshes have been drained and, it

may be said, that places permanently under water twenty-five years ago are now marshes utilized for grazing during the dry season, while the marshes of that period have become cultivated fields.

Such important physical changes necessarily have a marked effect upon the fauna and flora of the region. Aquatic plants and animals are being reduced in number and restricted in habitat while such nonaquatic species as are not held in check by man are increasing in numbers and extending their range. The influence of recent hydrographic changes is seen in the local distribution of certain species of mammals which are absent from some localities now well adapted for their habitat, although abundant not many miles away. This is especially true of some of the members of the squirrel family, as noted later.

Trapping was carried on at three localities, which are as follows: A place known as Bluegrass Landing, lying about 6 miles west of the village of Roselawn in Newton County; Mountayr, a village 15 miles southwest of the first place and in the same county; the Koehler farm, 6 miles southeast of Hebron and 2 miles from Aylesworth switch on the Pittsburgh, Cincinnati, Chicago and St. Louis Railway in Porter County. The first and last named places are on the banks of the Kankakee River, and are "islands" or sand hills which rise above the level of the marsh and are not subject to overflow. Collections were made at each place, both on the "island" itself and in the surrounding swamps on both sides of the river. Mountayr is situated near the border of the prairies, such as are found throughout much of northern Indiana and Illinois, but there are marshes of small area at this place also.

SYSTEMATIC LIST OF SPECIES.

DIDELPHIS VIRGINIANA Kerr.

OPOSSUM.

The opossum is fairly common, though less abundant than at some places in the southern part of the State.

ODOCOILEUS VIRGINIANUS (Boddaert).

VIRGINIA DEER.

Deer are said to have survived in this region as late as 1891.[a] It is not probable that any now exist here in the wild state.

SCIURUS CAROLINENSIS LEUCOTIS (Gapper).

NORTHERN GRAY SQUIRREL.

Sciurus carolinensis hypophæus MERRIAM, Science, VIII, 1886, p. 351.

The *Sciurus carolinensis hypophæus* of Merriam is characterized chiefly by the dark color of the underparts, and, so far as I am aware,

[a] Butler, Proc. Ind. Acad. Sci., 1894, p. 83.

there are no good cranial or anatomical characters by which it can be distinguished from *S. c. leucotis*. At Aylesworth I obtained fairly typical *leucotis*, and also one specimen which closely resembles the type of *hypophæus*. Besides these specimens there were others, illustrating various degrees of melanism. In one the back is essentially the same as in normal gray squirrels, but the underparts are somewhat darker, while others are darker both on the back and the underparts, and a few are almost entirely black, the gray annulations of the hair being scarcely noticeable. The series is not large enough to show complete intergradation, but it indicates that *leucotis* probably does intergrade with the black squirrels through "*hypophæus*." If the latter form were valid it would be an instance of two closely related subspecies living at the same locality, and the improbability of this is another reason for regarding *hypophæus* as a synonym of *leucotis*.

In the Kankakee Valley the gray squirrel is found chiefly in the more densely wooded swamps. At Mountayr it is unknown, and at Bluegrass Landing it is rare, but in the swamps south of Aylesworth it is very abundant on both sides of the river. Measurements of specimens collected at this locality are as follows: Average cranial measurements of 4 adults, Cat. Nos. 141716, 141718, 141719, 141722, U.S.N.M. (2 males and 2 females). Basilar length, 46 mm.; palatilar length, 26.4; zygomatic breadth, 33; palatal breadth (measured from inner side of anterior premolars), 8.2; greatest height of cranium above palate, 20; length of audital bullæ, 11.1. Skin measurements (average of 4 males, Cat. Nos. 141716, 141718, 141720, 141721, U.S.N.M., and 3 females, Cat. Nos. 141717, 141719, 141722, U.S.N.M.), total length, 470 mm.; tail, 220; hind foot, 61.

SCIURUS NIGER RUFIVENTER E. Geoffroy.

FOX SQUIRREL.

The fox squirrel is common at each of the places visited, and is found both in the swamps and in the groves on the higher ground. Albinos are sometimes taken in this region. Average cranial measurements of 4 specimens, Cat Nos. 141712–141715, U.S.N.M., from Aylesworth are as follows: Basilar length, 50.6 mm.; palatilar length, 28.6; zygomatic breadth, 36.6; palatal breadth measured from inner side of anterior premolar, 8.2; greatest height of cranium above palate, 20.5; length of audital bullæ, 10.8. Average skin measurements of the same specimens: Total length, 545 mm.; tail, 247; hind foot, 63.6.

SCIURUS HUDSONICUS LOQUAX Bangs.

RED SQUIRREL, CHICKAREE.

The red squirrel appears to avoid the swamps and is found only in restricted portions of the Kankakee Valley. At Roselawn and Mountayr it does not occur. I obtained one specimen near Aylesworth, and it is said to live in large numbers about the village of Boone Grove. It has also been taken at Laporte.

TAMIAS STRIATUS (Linnæus).

CHIPMUNK.

The chipmunk of this region seems to be the southern form, typical *striatus*. Apparently it does not occur at Bluegrass Landing, but it is abundant about Mountayr and occurs in fewer numbers at Aylesworth. It has also been taken at Laporte.

CITELLUS FRANKLINI (Sabine).

GRAY GROUND SQUIRREL.

This animal is locally known as the prairie squirrel. I obtained three specimens at Mountayr, where I found a colony living in a field of oats, to which they did not seem to be doing any damage. I could not learn of any other colonies in that vicinity, although it has been reported from Benton, Jasper, White, and Porter counties. Mr. W. S. Blatchley reports digging one out of a mound near Boone Grove on October 6, at which date it had already begun to hibernate.

CITELLUS TRIDECEMLINEATUS (Mitchill).

THIRTEEN-LINED GROUND SQUIRREL.

I noticed the burrows of the thirteen-lined ground squirrel in railway embankments at a number of places where I did not do any collecting, and it is probable that it has extended its range, locally, at least, by following these embankments through the marshes. This is another species which does not occur at Bluegrass Landing.

MARMOTA MONAX (Linnæus).

WOODCHUCK.

Woodchucks are very abundant, and seem to inhabit every sand hill and elevated point throughout the region. Porter County pays a bounty of 10 cents for each animal killed and a statement furnished me by the county treasurer shows that an average of about 1,400 woodchucks a year have been killed for the five years ending with 1905, at a total cost to the county of $700. Apparently the bounty has not caused any appreciable diminution in numbers.

I obtained a woodchuck which had been "treed" by dogs in a

sassafras bush, and an examination showed that its stomach was gorged with sassafras leaves. So far as I know it is not a usual habit for these animals to obtain their food from trees.

SCIUROPTERUS VOLANS (Linnæus).

FLYING SQUIRREL.

The flying squirrel is known to occur in the Kankakee Valley, although I did not obtain any specimens.

MUS MUSCULUS Linnæus.

HOUSE MOUSE.

Lives in the fields as well as in buildings.

MUS NORVEGICUS Erxleben.

HOUSE RAT.

Abundant about houses and farm buildings.

PEROMYSCUS LEUCOPUS NOVEBORACENSIS (Fischer).

WHITE-FOOTED MOUSE.

This species is abundant everywhere, being found in small numbers at places in the swamps where all the land within the radius of 1 mile is submerged for weeks at a time. I do not know how it exists at such times unless it lives on the supplies which squirrels have stored away in the trees. No doubt many individuals perish in the floods. In these wooded swamps the white-footed mouse is not as exclusively nocturnal as it is supposed to be elsewhere.

PEROMYSCUS MICHIGANENSIS (Audubon and Bachman).

MICHIGAN WHITE-FOOTED MOUSE.

I took this species only at Mountayr, where it was found in the bluegrass by the roadside and in the dryer pastures. I have never known the species to live in either swamps or woods.

MICROTUS PENNSYLVANICUS (Ord).

MEADOW MOUSE.

Like the white-footed mouse, this species is found in places which are submerged during the winter and spring months. Since it does not climb trees nor live in the woods I am unable to see how it escapes drowning. I did not find it in places remote from higher ground, as was the case with the former species, but at one place where a low hill covered with bluegrass was bordered by a marsh overgrown with coarse, high marsh grass, I trapped both on the hill and in the marsh for several days. On the hill I did not get a single meadow mouse, while in the marsh I got five and saw many runways. It is possible that they retreat to the hill in times of flood, and then, finding the marsh grass better suited to their taste, go back to it in the summer.

MICROTUS AUSTERUS (Le Conte).

PRAIRIE MEADOW MOUSE.

I did not take this species, but specimens collected by Mr. C. M. Barber at Laporte are in the collections of the Field Columbian Museum in Chicago.[a]

FIBER ZIBETHICUS (Linnæus).

MUSKRAT.

The muskrat was formerly extremely abundant in this region. Rev. T. H. Ball[b] says that during the period from 1834 to 1884 from 20,000 to 40,000 muskrats were trapped annually in Lake County alone. Since the work of draining the land has begun, the area suited to the habitat of these animals has diminished and consequently the number of the animals themselves is diminishing. However, they are still abundant and form an important source of revenue to many of the inhabitants. One trapper told me that he secured from 700 to 1,200 skins annually. Another man trapped 300 muskrats within a month during the autumn of 1904.

SYNAPTOMYS COOPERI STONEI (Rhoads).

STONE LEMMING MOUSE.

The genus *Synaptomys* has received considerable attention from mammalogists in recent years, but there is still lack of agreement concerning the status of some of the forms. Without attempting to settle all the points at issue, the facts, in so far as they relate to the identity of the Indiana form, are as follows: *Synaptomys cooperi* was described by Baird in 1857 from a specimen supposed to have come from northern New Jersey, the exact locality being unknown. In 1893 Rhoads[c] described *Synaptomys stonei* from May's Landing, Atlantic County, New Jersey. In 1896 Merriam[d] revised the genus, decribing *Synaptomys helaletes* from the Dismal Swamp, Virginia, and *S. h. gossi* from Neosho Falls, Kansas, and placing *S. stonei* in synonomy with *S. cooperi*. In 1897 Rhoads[e] again discussed the status of these forms, recognizing *stonei* as a subspecies of *cooperi*, and making *helaletes* a synonym of the former.

The following characters are said to distinguish *stonei* from typical *cooperi*: "Larger with much larger and more massive skull and

[a] Special effort was made to secure specimens of the red-backed mouse, *Evotomys*, but without success. It may occur in the Kankakee Valley, but it seems to be rare everywhere in Indiana.

[b] History of Lake County and the Ball Family, p. 181.

[c] Amer. Nat., XVII, p. 63.

[d] Proc. Biol. Soc. Washington, X, pp. 55–64.

[e] Proc. Acad. Nat. Sci. Phila., 1897, p. 305.

broader rostrum and incisors; colors darker, especially on the underside, which is more plumbeous or slaty (less hoary)." The average measurements of nine adults are: "Total length, 125 mm.; tail vertebræ, 20; hind foot, 20; greatest length of skull, 27.8."

I have seen no specimens of typical *Synaptomys cooperi*, excepting the skull of the type, nor have I seen specimens of *S. c. stonei* from near the type locality. However, a comparison of skulls from Indiana with the type of *cooperi* and with the type of *gossi* shows that they do not closely resemble either one, and that they differ from the former to about the same degree and in the same manner as given by Rhoads for *stonei*. The latter name being older than *helaletes*, it is here adopted for the form of lemming mouse from the Kankakee Valley, the status of the Dismal Swamp form being left an open question.

The skin of an adult male from Aylesworth measured as follows: Total length, 123 mm.; tail vertebræ, 18; hind foot 18. Average of two skulls, Cat. Nos. 141741, 141767, U.S.N.M., from Bluegrass Landing and Aylesworth: Greatest length, 28 mm.; palatilar length, 12.7; upper molar series, 7; width of rostrum, 5; greatest length of mandible, 16.2. Same measurements, in order for the type of *Synaptomys gossi:* 30; 14; 7; 5.5; 16.5. Same for the type of *S. cooperi* (the greatest length not being obtainable). 12; 6.5; 4; 15.

In the Atlantic Coast States *Synaptomys* is always found associated with sphagnum bogs and marshes. In Indiana it has been found only in dry, grassy fields. The two I obtained in the Kankakee region were both taken in dense bluegrass by the side of the road, and it did not seem to live in the marshy places where *Microtus pennsylvanicus* was most abundant.

GEOMYS BURSARIUS (Shaw).

POCKET GOPHER.

The pocket gopher is known to occur in Newton County, but it is rare, and I did not obtain any specimens.

ZAPUS HUDSONIUS (Zimmerman).

JUMPING MOUSE.

The only representative of this species that I obtained was taken from the stomach of a bull snake, *Pituophis sayi* (Schlegel).

ERETHIZON DORSATUM (Linnæus).

PORCUPINE.

I did not hear of this species, but there is a pair of porcupines in the State museum in Indianapolis, which were taken in Laporte County a few years ago.

LEPUS FLORIDANUS MEARNSI (Allen).

PRAIRIE COTTONTAIL.

The rabbit occurring here seems to be the western form of the common cottontail. This is to be expected, since it has been reported from central New York.

VULPES FULVUS (Desmarest).

RED FOX.[a]

The red fox is not common in the marshes, though occasionally taken there. At Mountayr they were very abundant and troublesome. One farmer told me that he had had 150 chickens killed by them during the spring and summer of 1905. He dug up some of the chickens they had buried and poisoned them and afterwards found the carcasses of four foxes which had been poisoned and he believed others were killed which he did not find.

CANIS OCCIDENTALIS (Richardson).

TIMBER WOLF.

The timber wolf is said to live in the Kankakee swamps in small numbers. Reports are conflicting, however, and the following species may be the only wolf surviving in that region at the present time. The proper specific name for the timber wolf of this region is also a matter of uncertainty.

CANIS LATRANS Say.

COYOTE; PRAIRIE WOLF.

There is no doubt that the coyote has increased in numbers and extended its range in northern Indiana during the past ten years. One reason for this is doubtless the fencing of the swamps for cattle ranges, which has made hunting on horseback impracticable. It may be also that the race has become better adapted to the presence of man by becoming more wary or by modifying its habits in some way. In a letter to the writer, Hon. L. Darrow of Laporte, says that he has seen as many as 20 prairie wolves in a pack on one occasion and at another time 8. Mr. C. W. Bussel, of McCoysburg, Jasper County, also writes that they congregate in large numbers during the mating season, which is in February. Mr. Bussel killed 10 of these animals during the winter of 1903–4, and other hunters also killed a number in the same vicinity. He further says that they live in burrows which they dig in the knolls on the prairie; that from 5 to 11 young are born to each female between the 1st and 15th of April; that these wolves

[a] The newspapers occasionally contain stories of "wild cats" being seen in this region and it is possible that the Canada lynx or the red lynx still exists in the swamps. However, the reports are too vague to credit.

generally avoid timber, although the young are sometimes brought forth in hollow logs instead of burrows, and that they frequently change the location of their dens, especially if they are approached by man or dog, so that it is almost impossible to find them and dig them out.

Two specimens, Cat. Nos. $\frac{143633}{49889}$ and $\frac{143634}{49890}$, U.S.N.M., taken by Mr. Bussel at McCoysburg in May, 1906, and sent to the U. S. National Museum, had the following measurements: Adult male—total length, 1,095 mm.; tail vertebræ, 165; hind foot, 195; height at shoulder, 560; ear, 105. Adult female, measurements in the same order—1,040; 130; 500; 110.

LUTRA CANADENSIS (Schreber).

OTTER.

Otter are becoming very scarce, but a few are still taken every winter.

MEPHITIS MESOMELAS AVIA (Bangs).

ILLINOIS SKUNK.

Skunks are common in this region, but I did not secure any specimens. They probably belong to this species, although it is possible that the eastern skunk, *M. putida* (Boitard), also occurs.

TAXIDEA TAXUS (Schreber).

BADGER.

Reported from Newton [a] and other counties in northern Indiana as rare. I obtained no definite records of its occurrence while in the region.

LUTREOLA VISON (Schreber).

MINK.

The mink is abundant in the wooded swamps along the river.

PUTORIUS NOVEBORACENCIS Emmons.

NEW YORK WEASEL.

Weasels are abundant at most points in the Kankakee Valley and are trapped for fur, although their skins are not very valuable.

PROCYON LOTOR (Linnæus).

RACCOON.

Abundant. Many are trapped for fur each year.

[a] Butler, Proc. Ind. Acad. Sci., 1894, p. 84.

BLARINA BREVICAUDA (Say).

SHORT-TAILED SHREW.

The short-tailed shrew is common everywhere except in the lower marshes. It is especially abundant at Bluegrass Landing, both in the woods and fields.[a]

SCALOPUS ACQUATICUS (Linnæus).

MOLE.

I saw the work of moles about Bluegrass Landing and heard of their occurrence there, but did not obtain any specimens. It does not live in the swamps and is not common anywhere in the vicinity of the river.

LASIURUS CINEREUS (Beauvois).

HOARY BAT.

There is a specimen of the hoary bat from Lake County in the State museum in Indianapolis.

LASIONYCTERIS NOCTIVAGANS (Le Conte).

SILVERY-HAIRED BAT.

Reported by Butler and Evermann[b] from Laporte County.

Other species of bats occur in this region, but I was unable to obtain definite records. I saw bats flying frequently and was shown where a colony had formerly occupied a hole in some old piling in the river at Bluegrass Landing. None was there at the time of my visit, but judging from the description they were probably the large brown bat, *Vespertilio fuscus*.

[a] I made an effort to get shrews of the genus *Sorex* but without success. One or more species of this genus certainly occurs in the Kankakee Valley but probably is not abundant.

[b] Proc. Ind. Acad. Sci., 1893, p. 134.

A NEW SALAMANDER FROM NICARAGUA.

By Leonhard Stejneger,
Curator, Division of Reptiles and Batrachians, U. S. National Museum.

In a small collection recently received from Dr. W. F. Thornton, Bluefields, Nicaragua, there is a very interesting new salamander, which it is desirable to place on record.

SPELERPES COLLARIS, new species.

Diagnosis.—Limbs and digits well developed, the latter extensively webbed, with the tips free; 19 costal grooves; palatine teeth extending exteriorly beyond choanæ, separated from parasphenoid teeth; snout truncate; body elongate, distance from snout to vent five times the distance to gular fold.

Habitat.—Nicaragua.

Type.—Cat. No. 37350, U.S.N.M. Topaz mine, "90 miles NW. of Bluefields, and 50 miles back in direct line from the coast;" elevation 400 feet.

Description of type specimen.—Palatine teeth in two slightly arched series extending outward beyond the choanæ and separated from the parasphenoid teeth by a narrow interval; parasphenoid teeth in two narrow and exceedingly long patches, which are confluent anteriorly, but well separated behind; head depressed, long and rather narrow; snout projecting, nearly truncate anteriorly, the labial protuberances below the nostrils strongly developed; body elongate, the distance from tip of snout to anterior end of vent measuring fully five times the distance from the same point to the gular fold; limbs rather short; fingers and toes short, extensively webbed, but with the tips free; (tail missing); skin smooth on top of head, finely granulated on the body; a distinct gular fold; 19 costal grooves, including the one in the axilla; vent a simple longitudinal slit. Color (in alcohol), uniform plumbeous, the body color being a mixture of minute black specks dusted over a pale ground; edge of gular fold and a semilunar mark around the insertion of the legs, as well as a spot

in the bend of the elbow and of the knee, pale; the side of the head shows indications of being pale with a large dark preocular spot and a narrow black postocular streak.

Dimensions.

	mm.
Tip of snout to gular fold	13
Tip of snout to vent	70
Axilla to groin	45
Width of head	8
Fore leg	10
Hind leg	12

Remarks.—This species is probably nearest related to *Spelerpes* (*Oedipus*) *parvipes* Peters, from Colombia, but the latter differs in many important particulars, being described as having only 17 costal grooves, a single patch of parasphenoid teeth and "fingers and toes little developed, united."

There are two other Central American salamanders having 19 costal grooves, but they belong to different genera. One is *Oedipina uniformis* Keferstein, which has a perfectly worm-like habitus, rudimentary digits and a single parasphenoid patch. The other is Cope's *Haptoglossa pressicauda*, which has the tongue adherent in front, while in the species here described the tongue is typically boletoid.

EIGHTEEN NEW SPECIES AND ONE NEW GENUS OF BIRDS FROM EASTERN ASIA AND THE ALEUTIAN ISLANDS.

By Austin H. Clark,
Of the United States Bureau of Fisheries.

This paper is based mainly on a collection of birds made by the late Mr. P. L. Jouy during a residence of over three years in Korea. It contains 554 excellent skins, mainly from Fusan, Chemulpo, Seoul, and Tsushima, with a few from Gensan, and is much the most important collection ever made in that country. Many of the species were not known from Korea at the time the collection was made, but most of these have since been recorded. There are a few which, although commonly supposed to be accidental in Korea, are represented by a considerable series, showing them to be of regular occurrence, at least during the migrations. Mr. Jouy was engaged in working up the collection at the time of his death, on March 22, 1894; but aside from notices of a few species in Dr. Leonhard Stejneger's articles on the avifauna of Japan, nothing has ever been published in regard to it.

In the preparation of a paper on the ornithological results of the recent cruise of the United States Fisheries steamer *Albatross* in the north and northwest Pacific and the Japanese seas, I have courteously been permitted to make use of this collection, which is most interesting in bringing out the relationship of the avifauna of Japan to that of Korea.

TISA[a] Clark, new genus.

Medium sized, semiterrestrial finches with the bill rather large, moderately stout, and conical.

Bill about half length of head, conical, the depth at base greater than its width at the same point, the distance from nostril to tip of maxilla equaling the gonys in length, and also equaling the distance from inferior corner of mandible to base of culmen. Culmen and gonys nearly straight, the former slightly decurved at tip; tomia of the maxilla nearly straight, with a small notch near the tip; nasal

[a] From the Russian птица (signifying bird).

grooves nearly filled with hairy feathers, with rather strong bristles at the base; culmen length of outer toe without claw, or one-half length of tarsus.

Wing about four times as long as tarsus, rounded, the first four primaries being about the same length (the first slightly shorter than the other three) with the fifth somewhat shorter.

Tail equal to distance from wrist to tip of tertials, square at the tip, the central feathers only very slightly shorter than the lateral.

Tarsus one-quarter length of wing and equal to the middle toe with claw. Hallux about length of inner toe, with a curved claw a little less than its own length.

Coloration, in only known species, slaty gray, mottled on the back with black and usually washed with brownish, the tertials bordered with brown and buff. Female, brown above, rump chestnut, lower parts yellowish buff obscurely streaked with brown.

Tisa variabilis (Temminck)[a] has been placed by various authors in the genera *Emberiza, Euspiza, Zonotrichia, Hypocentor,* and *Fringillaria,* while Seebohm[b] suggests that it should be placed in the genus *Spizella.* This bird shows a most remarkable superficial resemblance to *Phrygilus unicolor* (D'Orbigny) of western South America and to *Junco vulcani* (Boucard) of Costa Rica. In habits it resembles Junco or Zonotrichia.

Type of the genus.—*Emberiza variabilis* Temminck.

ARDEA CINEREA JOUYI Clark, new subspecies.

Type.—Cat. No. 114429 U.S.N.M.; male, Seoul, Korea, July 4, 1883; P. L. Jouy, collector.

Three specimens of this heron from Seoul, and a bird from the Tao River, just west of Min-Cheo, Kansu, China, differ from five specimens from Europe in being somewhat lighter above, with the wing coverts (particularly the distal lesser, the median, and the greater) much lighter, almost ashy white. This character appears to be constant as it holds good in all the specimens I have been able to examine. This is interesting in furnishing a parallel to the light eastern form of *Grus grus,* known as *Grus grus lilfordi.*

PHASIANUS KARPOWI BUTURLINI[c] Clark, new subspecies.

Type.—Cat. No. 114627 U.S.N.M.; male, Tsushima, Korean Straits, May 21, 1885; P. L. Jouy, collector.

Similar to *Ph. k. karpowi* Buturlin from Korea, but mantle and flanks paler, rump more grayish, tail (central rectrices) more olive and less yellowish, and less heavily barred toward the tip, and superciliary

[a] Temminck, Pl. Col., III, 1835, pl. DLXXXIII, fig. 2, *Emberiza variabilis.*

[b] Birds Jap. Emp., 1890, p. 139.

[c] For Mr. Sergius A. Buturlin, of Wesenburg, Esthonia, Russia, in recognition of his work on the genus *Phasianus.*

stripes broader and more conspicuous, beginning on fore part of crown (where they are separated by a tongue of dark green feathers from the forehead, equal to them in width) and extending to the nape. The bill is slightly shorter with the culmen more arched than in any of the seven specimens of *Ph. k. karpowi* before me.

This subspecies represents *Ph. k. karpowi* on the Tsushima Islands in the straits of Korea, where it is common.

LAGOPUS JAPONICUS Clark, new species.

Type.—Cat. No. 121179 U.S.N.M.; male, mountains of central Hondo, Japan; July 7, 1888; M. Kikuchi, collector.

This is a very dark form of the *Lagopus rupestris* group, in general appearance being most like *L. ridgwayi* Stejneger. It differs from specimens of that species taken in July in having the vermiculations of the upper surface much coarser and light buff in color instead of deep rusty. On the breast, sides, and flanks this species is even darker than *L. ridgwayi*, approaching *L. evermanni* Elliott; but what few markings there are are light buff and much coarser than in either of these species.

LAGOPUS RUPESTRIS CHAMBERLAINI[a] Clark, new subspecies.

Type.—Cat. No. 131867 U.S.N.M.; male, Adak Island, Aleutians, July, 1893; C. H. Townsend, collector.

This subspecies is nearest to *L. r. townsendi* Elliott, of Kiska Island, from which it differs in its finer vermiculations above, which give the bird a grayer appearance, and in having the conspicuous black bars on the neck and upper back of the Kiska bird reduced to very narrow bars or vermiculations, the whole plumage presenting a much more delicate pattern. The pattern on the breast, sides, and flanks resembles that found in *L. r. atkhensis* Turner, but the ground color is more grayish. In the character of its markings *L. r. chamberlaini* is intermediate between *L. r. townsendi* and *L. r. atkhensis*, but in general coloration it is much grayer than either, being the grayest of all the Aleutian ptarmigan. The female of *L. r. chamberlaini* is very finely marked above and below, resembling in this respect the female of *L. r. atkhensis*, but it is very much grayer than that bird above, and duller and less rufous beneath. The female of *L. r. townsendi* is heavily barred beneath, most nearly resembling the female of *L. evermanni* of Attu, of which the male is sooty black.

It is interesting to note that this, the grayest and one of the lightest of the Aleutian ptarmigan, occupies a position in the center of the Aleutian chain; on either side the birds become more rufous (*L. r. atkhensis* on Atka to the east, and *L. r. townsendi* on Kiska to the

[a] For Mr. F. M. Chamberlain, the naturalist of the U. S. Fisheries steamer *Albatross*.

west), while on the extremes of the chain we find the dark *L. r. nelsoni* on Unalaska, and the almost entirely sooty black *L. evermanni* on Attu.

ÆSALON REGULUS INSIGNIS Clark, new subspecies.

Type.—Cat. No. 114580 U.S.N.M.; male, Fusan, Korea; P. L. Jouy, collector.

A merlin from Korea which I have before me differs so much from European examples and from specimens from Japan that it seems probable it represents a new race. Unfortunately, the bird is in juvenile plumage with a few feathers of the adult in the back and one in the tail. It resembles *Æ. r. regulus* from Europe in the same plumage, but is much lighter throughout, with the brown streakings below lighter and much narrower. The gray feathers which are just appearing indicate that in the adult livery this bird will be much lighter than its European representative.

CERCHNEIS PERPALLIDA Clark, new species.

Type.—Cat. No. 114579 U.S.N.M.; male, Fusan, Korea; P. L. Jouy, collector.

This species resembles *C. tinnunculus* from Europe, but is paler throughout, except the thighs, which are in sharp contrast to the creamy white under parts. The gray on the head is paler, and is continued down onto the shoulders and interscapulary region, gradually merging into the rufous of the back; this color also occupies the sides of the head and neck, extending down onto the sides of the breast.

BUBO TENUIPES Clark, new species.

Type.—Cat. No. 114618 U.S.N.M.; male, Fusan, Korea; P. L. Jouy, collector.

Similar to *B. bubo* from Norway, but smaller, the feet and claws very much smaller and weaker, and the tarsus much more slender. The coloration above resembles that of *B. bubo*, but the ground color is darker rufous, with the dark mottlings more extensive, except on the nape, and the light areas on the primaries larger. Below this species is somewhat darker rufous than *B. bubo;* the feet are light rufous, obscurely, but thickly, barred with brown. The feathering of the toes is as in *B. bengalensis.*

The average measurements of three males from Korea are, wing, 439 mm.; tail, 245 mm.; tarsus, 80 mm.; middle toe, 46 mm.; claw of middle toe, 31 mm.

SYRNIUM MA[a] Clark, new species.

Type.—Cat. No. 114439 U.S.N.M.; female, Fusan, Korea; P. L. Jouy, collector.

Somewhat resembles *S. aluco* from Norway in the gray phase, but very much grayer with no trace of rufous, the wing coverts brownish gray instead of reddish brown; the head is brownish gray with a broken line of white from the base of the bill over the eye to the nape on either side, due to the presence of large white spots on each feather in this region. The nape, hind neck, and sides of the neck are spotted and mottled with white, the central dark areas of the feathers imparting a streaked appearance. The facial disc is as in *S. aluco*, but more uniformly gray, with no trace of rufous. The underparts are marked as in *S. aluco*, but the ground color is white, and the streaks and vermiculations brownish gray. The under wing coverts are white, more heavily streaked with brown than in *S. aluco*, and the feet are much more heavily barred than in that species. The first primary is 25 mm. longer than the same feather in *S. aluco*, equalling the ninth in length; the fifth primary is the longest, the fourth nearly as long, the third somewhat shorter, and the second intermediate between the fifth and seventh.

The type measures, wing, 297 mm.; tail, 192 mm.; tarsus, 57 mm.

SYRNIUM URALENSE JAPONICUM Clark, new subspecies.

Type.—Cat. No. 96393 U.S.N.M.; female, Sapporo, Hokkaido, October 18, 1882.

Although this and the following form are here described for the first time, the credit for pointing them out really belongs to Doctor Stejneger, for as long ago as 1893[b] he showed that they differed from the continental form, and also differed among themselves, although he did not name them.

Four specimens of the owl commonly referred to by writers dealing with Japanese ornithology as *Syrnium uralense* prove to belong to a well-marked subspecies, characterized by much smaller size and more heavily feathered toes, the feathering concealing the last joint and the base of the claws. The birds are uniform in coloration and are very pale, much paler than a bird from Romedal, Norway, before me, resembling a bird labeled as from northern Europe.

A male measures, wing, 267 mm.; tail, 200 mm. (much abraded).

Three females average, wing, 295 mm.; tail, 243 mm.

All the specimens are from the island of Hokkaido.

[a] *Ma*=elf; gnome (Japanese). [b] Proc. U. S. Nat. Mus., XVI, p. 626.

SYRNIUM URALENSE HONDOENSE Clark, new subspecies.

Type.—Cat. No. 109441 U.S.N.M ; male, Iwaki, Hondo, February 2, 1886.

Similar to *S. u. japonicum*, but darker and more brownish, the white above more restricted, the light markings on the primaries and secondaries more restricted and never reaching the shaft; bars on tertials and inner secondaries with dark centers, sometimes reducing bars to mere outlines; bars on central pair of rectrices reduced to a double row of irregular spots; dark central streaks of feathers of lower breast and abdomen suddenly expanding near tip into an arrowhead figure, which occupies the whole tip of the feather, and not tapering almost to a point as in *S. u. japonicum*. The feathering of the feet is as in *Syrnium fuscescens*.

The type measures, wing, 317 mm.; tail, 258 mm.

This subspecies represents *S. u. japonicum* of Hokkaido, in the island of Hondo.

DRYOBATES LEUCOTOS COREENSIS Clark, new subspecies.

Type.—Cat. No. 114112 U.S.N.M.; male, Fusan, Korea; P. L. Jouy, collector.

Resembles *D. l. leucotos* from Norway, but with the white above more restricted and the under surface tinged with pale buff, approaching *D. l. subcirris* from Japan. In *D. l. coreensis* the under wing coverts at the base of the primaries are dark brown, instead of white slightly mottled with brown as in *D. l. leucotos*. In the former the first primary has one spot of white (in one specimen an indicated second), the second primary two (the distal usually much the smaller), the third two (in one specimen an indicated third), and the fourth two larger and a distal smaller spot; in the latter the first primary has two white spots, the second two and an indicated third, the third three, and the fourth three, all of about the same size. The white patch on the upper wing coverts of *D. l. coreensis* is much smaller than in *D. l. leucotos*. The outermost tail feathers in *D. l. coreensis* are black, margined with white on the outer web only in two specimens; in two others the white extends over the tip and down the inner web for about two-tenths of an inch. The outermost large tail feather in one specimen has one brown subapical spot on the outer web, in two has two, and in one has two and a very small third. In *D. l. leucotos* the outermost tail feather has the outer web (more broadly than in *D. l. coreensis*) white, and two large spots of white on the inner web; the outermost large tail feather has three brown spots on the outer web.

The average measurements of two males from Fusan, Korea, are, wing, 144 mm.; tail, 93 mm.; culmen, 36.5 mm.; tarsus, 26.5 mm.

A female from Fusan measures, wing, 144 mm.; tail, 93 mm.; culmen, 33 mm.; tarsus, 25 mm.

DRYOBATES LEUCOTOS USSURIANUS Clark, new subspecies.

Type.—Cat. No. 108896 U.S.N.M.; female, Ussuri, eastern Siberia.

Resembles *D. l. coreensis*, to which it is most closely related, but the underparts are pure white, the rose red of the abdomen and under tail coverts clearer and somewhat paler, and the black striations of the under surface are finer and less numerous, and are confined to the sides of the chest and abdomen, not encroaching on the median area, giving the bird a much less streaked appearance.

The measurements of the type are, wing, 145 mm.; tail, 93 mm.; culmen, 34 mm.; tarsus, 27 mm.

GECINUS CANUS GRISEOVIRIDIS Clark, new subspecies.

Type.—Cat. No. 114120 U.S.N.M.; male, Seoul, Korea; P. L. Jouy, collector.

This subspecies resembles *G. c. jessoensis* Stejneger, but is darker and duller throughout. The gray of the head is darker than in *G. c. jessoensis*, but is washed with greenish as in that form. The green of the back is washed with gray, approaching *G. c. perpallidus* Stejneger. The underparts are of a darker gray than in *G. c. jessoensis*, with less of the greenish wash, especially on the flanks and under tail coverts.

It differs from *G. c. perpallidus* from Ussuri in being darker throughout, with the green on the back brighter and contrasting more strongly with the gray of the head. The under surface is darker, with a slight greenish tinge, and the head is slightly washed with green.

Compared with *G. c. canus* from Norway, *G. c. griseoviridis* is duller green on the back, and darker gray below.

A comparison with *G. c. zimmermanni* Reichenow from Shantung shows that *G. c. griseoviridis* differs in being much greener on the back, with a more greenish tinge below. *G. c. zimmermanni* seems to be a darker southern race of the Siberian *G. c. perpallidus*, as *G. c. griseoviridis* is a darker southern race of *G. c. jessoensis* of Hokkaido.

Pallas's name *Picus chlorio*[a] can not be applied to any one of the east Asiatic subspecies of *Gecinus canus*, having been proposed as a substitute for Gmelin's *Picus canus*.[b]

The average measurements of four males from Seoul and Gensan, Korea, are, wing 145 mm.; tail, 96.5 mm.; culmen, 35 mm.; tarsus, 26.5 mm.

The average measurements of three females from Seoul and Gensan are, wing, 146 mm.; tail, 97 mm.; culmen, 33 mm.; tarsus, 26 mm.

[a] Zoogr. Rosso.-Asiat., I, 1811, p. 408. [b] Syst. Nat., I, 1788, p. 434.

PERICROCOTUS CINEREUS INTERMEDIUS Clark, new subspecies.

Type.—Cat. No. 114253 U.S.N.M.; male, Seoul, Korea; P. L. Jouy, collector.

This subspecies differs from *P. c. cinereus* in being slightly darker and more brownish above, with the black of the head extending onto the shoulders where it merges with the gray of the back, instead of terminating in a well-defined line across the upper neck as in *P. c. cinereus.*

From *P. c. japonicus* Stejneger it differs in being somewhat darker and more brownish, with the black of the head merging into the gray of the back on the upper back, and not extending down into the interscapular region.

The females may be distinguished from the females of *P. c. cinereus* and *P. c. japonicus* by the color of the upper parts, which are duller and more brownish.

In size *P. c. intermedius* agrees with *P. c. cinereus,* being somewhat less than *P. c. japonicus.*

OLBIORCHILUS FUMIGATUS PENINSULÆ Clark, new subspecies.

Type.—Cat. No. 114200 U.S.N.M.; female, Fusan, Korea; P. L. Jouy, collector.

Resembles *O. f. fumigatus* from Japan, but duller and less rufescent above, with the underparts somewhat lighter, and the light markings on the ear coverts and sides of head clearer and more extended. This bird approaches *O. f. idius* Richmond from Shantung, but is more rufous in color, with the markings below less pronounced.

A male from Fusan, Korea, measures, wing, 52 mm.; tail, 33 mm.; culmen, 10 mm.; tarsus, 19 mm.

The measurements of a female from the same locality are, wing, 48 mm.; tail, 32 mm.; culmen, 11 mm.; tarsus, 18 mm.

OLBIORCHILUS FUMIGATUS AMURENSIS Clark, new subspecies.

Type.—Cat. No. 114661 U.S.N.M.; male, Amur.

Similar to *O. f. fumigatus* from Japan, but darker above, particularly on the head, which is very dark. The underparts are rather more grayish than in *O. f. fumigatus,* and more distinctly marked.

The type measures, wing, 52 mm.; tail, 34 mm.; tarsus, 18 mm.; culmen, 12 mm.

REMIZ CONSOBRINUS SUFFUSUS Clark, new subspecies.

Type.—Cat. No. 114191 U.S.N.M.; male, Fusan, Korea; P. L. Jouy, collector.

Similar to *R. c. consobrinus* from Japan, but much more buffy throughout, the upper parts brighter (less grayish) buff, the underparts pinkish buff instead of buffy white, this color extending to the

base of the bill, causing the white malar patches to appear very distinct. The borders of the rectrices are buff instead of nearly white.

Unfortunately, I have before me only four specimens, two from Japan and two from Korea, not having been able to obtain any from southern China (typical *R. c. consobrinus*) for comparison. From what has been written on this species, however, I judge that birds from China and Japan are alike in color, and the description of the type fits my Japanese examples very well. The Japanese birds, however, are smaller than the bird described by Swinhoe, which agrees with my Korean specimens in size; a careful comparison of Chinese and Japanese specimens will probably make it necessary to recognize a *R. c. japonicus*.

ACREDULA TRIVIRGATA MAGNA Clark, new subspecies.

Type.—Cat. No. 114186 U.S.N.M.; male, Seoul, Korea; P. L. Jouy, collector.

Similar to *A. t. trivirgatus* from Japan, but larger, with a much longer tail, with the white patch on the crown more extended, and the dark stripe from the bill to the nape on either side (which is brownish in color) consequently narrower, and with the white on the tertials strongly tinged with buffy for their basal half.

The measurements of the type are, wing, 67 mm.; tail, 99 mm.; tarsus, 17 mm.

Six specimens of *A. t. trivirgatus* from Hondo average, wing, 60 mm.; tail, 80 mm.; tarsus, 17 mm.

THE SKULL OF BRACHAUCHENIUS, WITH OBSERVATIONS ON THE RELATIONSHIPS OF THE PLESIOSAURS.

By Samuel W. Williston,
Of the University of Chicago, Chicago, Illinois.

The type of the genus and species *Brachauchenius lucasi* Williston[a] is an excellent specimen in the collection of the United States National Museum from the Benton Cretaceous of Western Kansas. The genus is of unusual interest because of several remarkable characters previously unknown among the plesiosaurs, which it possesses, in particular the union of the palatine bones in the middle line, and the very short neck. A second specimen belonging to the same genus, from the Eagle Ford Limestone of Texas, also forming a part of the collections of the United States National Museum, was kindly submitted to me for study by the authorities of that museum, a brief notice concerning which was published in Science for June 19, 1903.

These two specimens supplement each other, the type specimen showing the underside of the skull and the connected vertebral column as far as the lumbar region (Plate XXXIV), while the present specimen permits a thorough examination of the upper part of the skull, and has, also, eighteen of the early vertebræ, and a part of the front paddle. The most careful comparisons fail to discover generic differences between the two specimens, nor can I detect specific differences even. The Texas specimen is partly inclosed in a hard limestone matrix, and it is possible that, when the underside of the skull shall have been cleaned up, specific differences may be apparent, but I do not think so. The specimen is slightly smaller than the type. The Eagle Ford Limestone is known to be an equivalent of the Benton Cretaceous, and I suspect that the immediate horizon in which the specimen occurred will prove to be an exact equivalent of that which yielded the Kansas specimen.

[a] Field Col. Mus., Pub. No. 73, Geol. Ser., II, p. 57; Lucas, Smithson. Misc. Col. Quart., I, p. 96.

The skull of the Texas specimen is moderately elongated, not nearly so much so as that of *Trinacromerum* or *Polycotylus*, but more so than is the skull of the known species of *Elasmosaurus*. The temporal fossæ are unusually large, the zygomatic bars remarkably slender posteriorly, and the parietal bone is not elevated into a thin, high crest as is the case with the skulls of the genera mentioned, but is low, straight, and obtusely rounded on its upper surface. The teeth are fewer, less elongated than in those genera; they are coarsely striate. All parts of the skull are present, save the anterior portion of the premaxillæ.

Premaxillæ.—Of the premaxillæ, the anterior portion has been destroyed, the two posterior teeth on each side only remaining. Since most other forms of plesiosaurs have six teeth on each premaxilla, it is probable that this number was originally present in this specimen, though Andrews gives [a] but five as the number in *Pliosaurus ferox*, a related form. Perhaps two-thirds of the dentigerous portion is missing, and I have so restored the outline of the skull (Plate XXXVII). The facial processes are as in the other forms of plesiosaurs described by me—elongate, parallel processes, with a distinct longitudinal striation, terminating by overlapping the frontals or parietal processes a little in advance of the anterior end of the orbits. Their width throughout is nearly uniform. They articulate, on the outer side of the skull, with maxillæ, frontals and (?) parietals.

Maxillæ.—Each maxilla attains its greatest width over the external nareal opening. It is here separated from the premaxillary process by a slender, pointed projection from the frontal or nasal. Between this process and the naris, an elongated tongue-like process extends on the frontal or nasal to a little beyond the posterior end of that opening. Below, the union with the prefrontal begins a little in front of and below the anterior end of the nareal opening and extends downward and backward to the most anterior extremity of the lachrymal. On the right side of the specimen the front part of this suture is apparent, but in the middle of the course there has been an inward bending on the line of the suture. On the left side, however, the maxilla, while a little displaced, has been separated from its contiguous elements, making certain that the infolding has been at the sutural junction. The maxilla lies somewhat over the prefrontal squamately and helps form only the most anterior part of the nareal opening. The maxillary suture turns backward below the lachrymal to terminate acutely a little before the posterior end of the orbit, joining the jugal posteriorly.

(?) *Frontals*.—The bones which I here call the frontals, for reasons given further on, lie at the sides of the parietal prolongations, extending anteriorly as slender projections between the maxillary and pre-

[a] Andrews, Quart. Journ. Geol. Soc., LIII, 1897, p. 177.

maxillary processes already described. Each bone is overlapped in part in front by the tongue-like processes of the maxilla, and I can not be sure whether any part of it reaches the nareal border, though I think not. Near the posterior extremity of this tongue there is a very distinct suture, extending backward and a little outward for a short distance, thence nearly directly backward to a point above the uppermost part of the orbit; on the left side the bone has been separated at this suture. Posteriorly, on the outer side, the bone joins the postorbital for a short distance obliquely; the suture then turns inward to join the parietal transversely. The bone is long, pointed anteriorly, flattened or gently concave above in its middle, united on its inner side in front with the premaxilla, behind with the rostrum of the parietal, posteriorly with the postfrontal and postorbital, on the outer side with the prefrontal. It is of course possible that the bone, as described, is composed of two elements, the most anterior of which would be the nasal, but of such division there is no evidence in this specimen. (See Plate XXXVII, *fr? na?*.)

Prefrontals.—The prefrontals are rather broad, irregularly shaped bones, forming the whole of the antero-superior border of the orbits and the posterior inferior margins of the nares. The inner border of each bone, as already described, joins the frontal throughout. Posteriorly, for a short distance, it joins the postorbital, differing in this respect from the prefrontals of *Trinacromerum*. Its orbital border is thin and arched, terminating at the extreme front angle of the orbit. Below, the bone joins the lachrymal by a short suture running forward and outward in continuation of the line of the orbital margin to the maxillary suture, which has been described. Anteriorly the bone is emarginated by the hind border of the nareal opening, the tongue of the maxilla, as described, overlapping it and concealing its extent. The bones are convex and smooth, each pierced by two small foramina. On the left side the bone, while not crushed or distorted, has been separated from the adjoining bones and forced upward somewhat. Inasmuch as its shape and extent on this side agree quite with those of the opposite side, as determined from the sutures, there can be no doubt of its relations and form. There is no indication on either side of a sutural division.

Parietals.—The parietal foramen is an elongated opening, oval in shape and about 40 mm. in length. In front of the foramen, the parietals appear to continue forward as an elongated, narrow rostrum, to disappear under the facial extremity of the premaxillæ, divided in the middle by a distinct suture from a little in front of the foramen. The surface on either side of this mesial suture is plane or concave, presenting a number of distinct longitudinal ridges and grooves, which begin near or on the sides of the foramen. The greatest width of these prolongations is at the hind end, where they together measure 50 mm.

Where they disappear beneath the premaxillæ they have a combined width of about 35 mm. On each side the parietal turns downward and slightly outward into a thin descending process or wing, forming the lateral wall of the brain case to a depth of 60 mm. At the anterior inner angle of the temporal vacuity there is a rather strong emargination of this descending wall for the attachment of the epipterygoid, from the upper margin of which a somewhat zigzag sutural line runs upward and then forward to join the extremity of the suture between the prefrontals and frontals. These lines appear to be quite alike on the two sides and since they agree with the sutural divisions in *Trinacromerum osborni* and also with the recognized sutures in the skull described by Andrews as *Pliosaurus ferox*, there can be no question, I think, but that they indicate the divisions between the parietals and postfrontals. Back of the parietal foramen the parietals show no clear indications of a median suture. The part here, for the rather long distance between the temporal vacuities, is obtusely rounded above and nearly horizontal, very unlike the thin, elevated crest of *Trinacromerum*, *Polycotylus*, and *Elasmosaurus*. On the under side the parietals include a deep valley between the lateral walls, a little wider below and meeting in a rounded roof above, for the brain case. This cavity measures over 50 mm. in its greatest width.

The arrangement of the bones in the frontal and antorbital regions, as I have described them, whatever may be their interpretation, doubtless obtains in all plesiosaurs, with minor modifications. Whichsoever interpretation may be finally accepted the arrangement and structure are very remarkable and very unlike what is known in other reptiles. That the bones are nearly or quite as I have described them in this specimen I have no doubt. Andrews, in his figures and description of the skull of *Pliosaurus ferox*, reaches different conclusions and has different interpretations, but I am confident that, if his specimen be studied in the light of the information furnished by the present one, other conclusions and other interpretations will be reached. A positive suture has never been detected separating the median bones in front of the pineal foramen from the parietals. Owen, it is true, thought he detected such a suture in a species of *Plesiosaurus*, and Andrews thought there was one in his *Pliosaurus ferox* specimen, though he adds that the parietals are probably anchylosed with the "frontals." I have been unable to distinguish such a suture in four well-preserved skulls of as many different genera studied by myself. In the specimen of *Trinacromerum osborni* studied by me, while the adjacent sutures are all clearly indicated, save such as were obliterated by crushing, the very narrow prolongations in front of the foramen have no trace whatever of a distinguishing suture, either on the upper or the under side. I believe them

to be merely exogenous processes from the parietals, produced forward to meet the extraordinarily elongated premaxillary processes.

If such be really the case, the bones on their outer sides must of course be the frontals, and, as frontals, they occupy their normal relations with the adjacent bones, save only the parietals, articulating behind with the postfrontals, in front exteriorly with the prefrontals, anteriorly with the maxillæ and premaxillæ. If the median bones be really the anchylosed frontals, then these bones must be the nasals. As such, however, their relations would be most extraordinary, the only instance in comparative osteology where they articulate with the postfrontals and postorbitals.

Possibly the same causes which have prolonged so far backward the premaxillaries may have caused a posterior displacement of the nasals. In any event I feel sure that the bones on the outer sides of these, the supposed supraorbitals, the ones bordering the orbits and reaching to the nares, are the real prefrontals. As such their position and relations are not extraordinary. As supraorbitals they are quite indefensible.

If the former interpretation be correct, that the parietals have excluded the frontals from contact in the middle line, the nasals are wanting in the plesiosaurs. If the latter interpretation is correct, then all the elements of the normal reptilian skull are present, but the nasals have become abnormal in position and relations. I do not know how the problem can be settled, unless, indeed, some favorably preserved specimen may disclose an actual suture in front of the parietal foramen.

Lachrymals.—The lachrymal is an elongate bone forming the lower anterior half of the orbital margin. Its sutural union with the prefrontal is very evident on each side; the suture between it and the maxilla is perhaps not wholly free from doubt in this specimen, though there can be little possibility of error, the indications of the two sides agreeing as they do. The bone joins the jugal behind by an oblique suture; the maxilla in the middle below; and the prefrontal anteriorly, as already described. Inasmuch as these relations seem to be quite the same as those described by Andrews in *Pliosaurus ferox*, I think that the presence of a lachrymal as a distinct bone in the plesiosaurs may be finally set at rest. In the skull of *Trinacromerum osborni*, previously described, there is a pointed process of bone which has the same relations with prefrontals and maxillæ, but not with the jugal. I could not detect a suture separating it from the maxilla. Neither is it probable that the lachrymal in *Elasmosaurus snowi*, which must resemble that of *Trinacromerum*, articulates with the jugal.

Postfrontals and postorbitals.—The postfrontals and postorbitals I believe are distinct bones in this specimen. The parieto-post-

frontal suture I have already described. A suture quite as evident on each side runs obliquely outward from the hind end of the frontals or nasals, and then turns downward, about as figured by Owen for *Plesiosaurus*. The postfrontal, as thus defined, joins the parietal and touches the epipterygoid internally, the frontal anteriorly, and the postorbital exteriorly. The postorbital articulates with the prefrontal anteriorly, the postfrontal on the inner side, and, by its anterior angle, the so-called frontal; and the jugal exteriorly. The two bones, seen from behind, present a broad, nearly vertical wall, deflected somewhat anteriorly below, and ending in a thin, sharp, nearly horizontal margin, continued from the epipterygoid notch to the jugal. The orbital border of the postorbital is thinned, somewhat serrated, and concave. The temporal border above is sharp and angular, curving downward to terminate in the thin upper margin of the zygoma. The bone outwardly is massive and strong, ending in a horizontal suture, which is nearly continuous with the lower border of the orbit and the upper front border of the zygoma.

Jugals.—The jugal differs considerably from that of other forms of plesiosaurs known to me. The sutures distinguishing it from the postorbital, lachrymal, and maxilla are very clear, as I have described and figured them. That uniting it with the squamosal is doubtful. On the left side the bone has been separated very cleanly from the matrix, and is in a beautifully undistorted condition. A little back of the hind border of the postorbital there are, near the middle of the jugal, the orifices of two or three malar canals. These canals are very characteristic of the plesiosaurs, and usually open near the squamoso-jugal suture, but there is not the slightest indication of such a suture here. These canals, piercing the jugal, enter the orbit near its lower posterior corner. In the orbit the jugal turns inward for a considerable distance, forming a bowl-like floor posteriorly; its inner border I can not trace.

Describing the zygoma as a whole, it has a somewhat thickened upper border in front, thinned below. The arcade diminishes rapidly in width, chiefly at the expense of the lower part, to beyond its middle, where its width is less than one inch, and the bone is thin and weak. At this place the arch, on both sides, shows an oblique fracture, which may, possibly, represent the squamosal suture, though I am very doubtful. I have indicated this possible suture by dotted lines in the drawings. The squamosal behind broadens to a width of about two and a half inches where it joins the quadrate, and is thicker here, the upper border ascending rapidly; the lower border is concave. The zygoma is very remarkable for its attenuation posteriorly, leaving a large open space above the posterior part of the mandible in front of the articulation. I can conceive of the complete erosion of the bar here, as occurs in some turtles, leaving the temporal vacuity broadly

open on the sides. It would seem that the chief support for the mandibular muscles must have been on the sides of the parietals and the stout postfrontals and postorbitals.

The limits of the squamosal above can not be determined, owing to the erosion of the specimen, as indicated in the drawing. The parieto-squamosal arch is, however, quite stout, narrowed anteroposteriorly near its upper part. The massive quadrates are exposed below on the outer side and behind. Further information concerning the occipital region can not be had until the matrix has been removed; the anterior cervical vertebræ are crowded into this space.

At the bottom of the large temporal vacuities the supraoccipitals, exoccipitals, petrosals, and stapes were found more or less disarticulated and separated. The larger part of the exoccipital is seen somewhat removed from its relations to the stout supraoccipitals. Its anterior, cranial surface presents a deep pit and marginal sutural surfaces, completed by union with the supraoccipital and petrosal. The paroccipital process is rather slender, directed downward, outward, and backward in life, with its distal extremity flattened and apparently spatulate, for union with the upper end of the quadrate, as described in *Trinacromerum osborni*.

Petrosals.—The petrosal is a peculiar bone. That of the left side has been wholly freed from its matrix; on the right side it lies with its free, convex, outer side exposed near the front border of the temporal vacuity. Exteriorly the bone is nearly evenly and smoothly convex, shell-like. The inner side I have figured in Plate XXXV (*pet*), natural size. Its precise mode of union with its two contiguous bones can not be determined. Its two diverging canals doubtless lead into the supraoccipital and exoccipital sinuses or semicircular canals, as I have found them in *Trinacromerum osborni*. The greater part of the bone is deeply and smoothly excavated for the internal ear, leaving a free border for the petrosal part of the large foramen ovale. The excavation is deep and large for the size of the skull, much larger proportionally than in the mosasaurs.

Stapes (?).—A small and peculiar bone, lying apparently nearly in position in the matrix on the right side, I can determine only as a stapes, a bone hitherto unknown among the plesiosaurs. It is a short, stout bone, a side view of which is shown in Plate XXXV (*st*) natural size, not unlike a human metatarsal, though less slender, with an attenuated, cylindrical shaft, and an articular expansion at either end. What I believe to be its proximal end, from its position in the matrix, presents a hemispherical articular surface, bounded by a shelf-like ridge, as though for articulation in a foramen. The other extremity is obliquely expanded, concave somewhat from side to side, smooth, and with a partial longitudinal ridge near one side. The extremity of the bone has been broken away.

Where the external ear was located is a puzzle. In all probability there was an external tympanic closed membrane, as in the turtles. The shortness of the stapes, if stapes this bone be—and there is no other place in the skeleton where it can be located—must mean an external surface close to the median line of the skull. There are no indications of an otic foramen or notch anywhere about the quadrate that I have discovered in this or other specimens of plesiosaurs. Dollo has ventured the opinion, from the thickness of the preserved cartilage about the external ear in certain mosasaurs, that they, or certain types of them at least, were deep-sea divers, from the resemblance in the structure to that of the cetaceans. This ear cartilage is very abundant and very thick in *Platecarpus* and *Tylosaurus*, less so in *Clidastes*. No calcified cartilage of any kind have I ever observed anywhere in the skeletons of plesiosaurs, so that any inference as to the habits of the plesiosaurs from its absence about the ear would not be legitimate.

Paddle.—A part of a paddle, evidently an anterior one, shown in Plate XXXVI, was found in this specimen lying closely upon and across the face of the skull. Not much information as to the generic or specific characters of the form can be deduced from it, but I give, nevertheless, a good photographic view of the specimen. The limbs were evidently not of the slender type of the elasmosaurs, but whether or not there was a duplication of the epipodials can not be determined.

Vertebræ.—The remains of twelve cervical and six dorsal vertebræ are preserved in the limestone matrix back of the skull. They agree in all respects with the vertebræ described by me in the type specimen of *Brachauchenius lucasi*, save in their slightly smaller size. The cervical series is connected, as are also five of the dorsals, which are curved forward reversed by the side of the cervicals. Doubtless the specimen originally was composed of a large part, perhaps the larger part of the skeleton, though only the single block containing the skull and vertebræ and the attached paddle was secured by the collector. At the angle of the vertebral series one or two may have disappeared, but probably not more. I have every reason to believe that the number of the cervicals is the same as in the type, namely, 13. The cervicals measure, in length, beginning with the axis: 25, 25, 25, 25, 28, 28, 30, 33, 35, 40, 40 mm. The dorsals preserved: 45, 50, 60, 60, 60 mm. The centra of the dorsals are smoothly rounded on the under side, without excavations or vascular foramina, resembling dinosaur vertebræ so closely that it would be difficult to distinguish their centra if preserved singly. The cervical ribs are single-headed, with not the least indication of division.

The total length of the skull, with the missing premaxillary portion estimated, is about 0.80 m., the width at the posterior part of the orbits 0.35 m. The length of the type specimen is about 0.90 m.; the width proportionally the same.

Relationships of Brachauchenius.—The most distinctive characters of the genus are found in the broadly united palatines, the broad union of the pterygoids posteriorly, the short, deep-set interpterygoidal vacuities, the ridge-like buttresses of the pterygoids, the remarkably small number of the cervical vertebræ, the absence of vascular foramina on their under side, the single-head cervical ribs, etc. The dorsal surface of the skull has a remarkable resemblance to that of *Pliosaurus ferox*, as figured by Andrews. Andrews assumed that the palatines in his specimen were separated by the pterygoids throughout, but expressly says that indications of the palatine relations posteriorly are wanting. I have scarcely a doubt but that they will be found to have the same structure as in *Brachauchenius* in better preserved specimens of the genus.

Much stress has been placed upon the palatal structure in the reptiles as indications of phylogenetic relationships, but I have never had a great deal of faith in the stability of these parts. Here we have the union or separation of the palatines in the same order. The general shape of the skull, the depressed parietals, and, I am confident, the relations of all the other bones of the upper side of the skull, are all nearly alike in *Pliosaurus* and *Brachauchenius*. Furthermore, in the reduced number of the cervical vertebræ in the two forms, 18 or 20 in the older, 13 in the younger, we have a genetic resemblance, I believe, one that strengthens my assumption that the shortened neck in the later forms is not a primitive character, but a degenerate one, one that has been acquired in more than one phylum. Indeed, so far as all these characters of the skull go, in the probability that the arrangement of the skull bones will be found essentially alike in the two genera, I should hesitate to separate the two types generically, were it not for the cervical ribs, single-headed in *Brachauchenius*, double-headed in *Pliosaurus*. The character of the cervical ribs has been considered as of more than generic importance, Seeley even proposing an ordinal subdivision based upon the divided or undivided neck-ribs. Here, too, I believe that the fusion of the imperfectly differentiated heads is a feature common to more than one line of descent, and is of no more than generic importance. It is a fact that all known American Cretaceous plesiosaurs have cervical ribs with undivided heads, and that is probably the case with all Cretaceous forms, as it is also with the known American Jurassic ones. Double-headed ribs are a primitive character confined to the early forms, for the most part.

In conclusion, I would suggest that the family Pliosauridæ be maintained, based upon the common characters apparent or probable in *Pliosaurus* and *Brachauchenius*.

The characters of *Brachauchenius*, so far as they are now known, I give as follows:

Brachauchenius.—Mesocephalic. Teeth not more than 20 in each

maxilla, strongly ridged and anisodont. Parietals rounded and obtuse above, not elevated into a crest. Temporal vacuities large; zygomatic bars slender posteriorly. Pterygoids broadly united in the middle behind; the interpterygoidal vacuities short, at the bottom of a depressed pit. No palatine foramina. Palatines broadly united in the middle in front of the pterygoids. Cervical vertebræ 13 in number, smoothly rounded below, without vascular foramina, shallowly concave at extremities; cervical vertebræ broader than long; cervical ribs single-headed. Benton Cretaceous of Kansas and Texas.

Relationships of the Plesiosaurs.—In the attempt to reach some definite conclusions as to the habits of the plesiosaurs, I gave[a] five years ago the following list of adaptive characters in aquatic, air-breathing vertebrates:

1. Elongation of the head, with attenuation of the facial region.
2. Elongation of trunk and tail, but especially the latter, with progressive weakening of the zygapophysial articulations posteriorly.
3. Shortening of the neck.
4. The acquirement of a caudal fin.
5. The acquirement of sclerotic plates.
6. Recession of the external nares.
7. Absence of the sacrum and the absence or progressive obsolescence of the sternum.
8. Greater slenderness and smaller size or loss of the hind limbs.
9. Hyperphalangy and hyperdactyly.
10. Smoothness of the skin.
11. Sponginess of the bones of the skeleton.
12. Increase in number and decrease in size of teeth.

The exceptions which the plesiosaurs present to these adaptations are:

1. Elongation of the neck, with increase in number of vertebræ.
2. Shortening of tail and body, and the flattened, depressed form of the latter.
3. The presence of a well-defined sacrum of three vertebræ.
4. The somewhat greater slenderness of the hind limbs, but with little or no decrease in effectiveness as propelling organs.

In these exceptions the plesiosaurs agree with the marine turtles. In the tail-propelling, aquatic vertebrate the propodial bones are invariably shortened, as for instance in the Cetacea, Ichthyosauria, Pythonomorpha, and the front legs of the Thalattosuchia, and the limbs become merely equilibrational organs in direct proportion to the effectiveness of the tail as a propelling organ. Experiments on fishes show that the loss of the paired fins does not impair the swimming powers of the individual, but does require the constant vibrational use of the tail in the preservation of the equilibrium, while the

[a] Kansas University Science Bulletin, I, 1902, p. 259.

loss of the caudal fin results in the total disability of the animal. In animals propelling themselves wholly or chiefly by the aid of the limbs the propodials are not shortened, but are, on the contrary, elongated, as in the plesiosaurs and marine turtles. The reason is obvious: The propodials become elongated handles of oar-like organs, of which the blades are formed by the progressively widened epi-, meso-, and metapodial elements, and the phalanges. The front limbs of the plesiosaurs are always broader and stronger, but not longer than the hind ones. The front legs of the marine turtles are not only broader and stronger, but also longer than the hind ones, though the latter have by no means lost their effectiveness as propelling, or, more probably, guiding organs. The connection of the hind limbs of the plesiosaurs with a well-developed sacrum of three vertebræ conclusively proves the propelling function of these limbs, if such proof were not abundantly furnished by the limbs themselves.

We have, then, certain marked resemblances in the form and mode of progression between the plesiosaurs and turtles, as contrasted with the tail-propelling type presented by the ichthyosaurs, mosasaurs, and thalattosuchians; and Fraas uses[a] this resemblance as a support for the diphyletic grouping of the reptilia by Osborn into the Synapsida and Diapsida, the former having the oar-propelling type, the latter the tail-propelling type. But the argument is fallacious; the resemblances in mode of progression and bodily form no more imply a common phyletic origin than do the much more marked resemblances of the ichthyosaurs and dolphins.

It is chiefly because of the external resemblances of form and similarity in mode of locomotion in the water that it has been generally and indefinitely assumed, from Buckland's time to the present that the plesiosaurs were related to the turtles. How well this hypothesis is sustained by the internal structure may be shown by the following comments:

In addition to external resemblances and undoubted similarity in habits of life, two other characters have been often cited as evidence of relationship between these two orders—the epiphysial mode of ossification of the propodials (or rather of the humeri, since there is no evidence yet that the femora have the peculiar "epiphyses"), and the fusion of the procoracoid with the scapula. As to the first of these assertions, recent careful investigations by R. Moodie conclusively prove that the turtles do not have true epiphyses, and as was long ago stated by Dollo, and recently confirmed by Mr. Moodie, the lizards do have, many of them, at least, distinct terminal bony epiphyses on their long bones. The mode of ossification of the humerus of the plesiosaurs is most extraordinary, without known parallel among reptiles, or mammals either, so far as that is con-

[a] Jahresheften d. Vereins f. vaterl. Naturkunde in Würtemberg, 1905, p. 363.

cerned.[a] The presence of "epiphyses" forming nearly the whole of the humerus, their apices separated in the middle of the bone by perforating canals extending through the shaft of the bone, is utterly unlike anything that has been observed in turtles or any other reptiles at any stage of their existence. I trust that the myth of epiphyses as an evidence of relationship between the turtles and plesiosaurs may not reappear again.[b]

As to the structure of the scapula, all students of the plesiosaurs are now agreed that the procoracoid does not unite with the scapula, whatever may be the case in the turtles (where it is equally improbable). The presence of a distinct foramen in the coracoid of many plesiosaurs, or its deep emargination posteriorly, points, I think, to a normal reptilian manner of development of this bone. The triradiate structure of the scapula is simply a parallel character, brought about by the same causes which have produced the enormous development of the coracoids, a structure absolutely lacking in the earlier and simpler nothosaur type, where it would confidently be expected were the orders genetically allied.

Whatever of resemblance there may be in the form and habits of these two orders of animals has been due solely to parallel evolution, to similar aquatic adaptations. In their internal structure they are really remote from each other, and neither could have been derived from the other type, not even in a remotely antecedent stage. The turtles have a stegocrotaphous skull, unlike all other reptiles save the Cotylosauria, Procolophonia, etc. The plesiosaurs have a large temporal vacuity, larger indeed than is to be found in any other reptiles of the therocrotaphous (I coin the word) type. Leaving out of account adaptive characters, we have the following most important differences in the structure of the two orders: The turtles lack the lachrymal, postorbital, and transverse bones, all well developed in the plesiosaurs. They have a distinct opisthotic, wanting in the plesiosaurs, and a large quadratojugal, probably wholly wanting in the plesiosaurs. The plesiosaurs have a large pineal foramen, wholly

[a] See Williston, Field Columbian Mus. Publ. No. 73, p. 73.

[b] In the pigeon "at four days there are two cones of gradually ossifying cartilage, the apices of which are close together in the middle of the bone, at the point where the primary center of ossification occurred, while the bases, quite unossified, form the articular ends. These two cones are ensheathed by a layer of periosteal bone, which of course is thickest opposite the ends of the cones, and thins off as the two extremities are approached. . . . These two cones probably represent the so-called epiphyses of the Plesiosaurus. I have not been able to find that this reptile possessed anything corresponding to true epiphyses." (Parsons, Jour. Anat. and Physiol., XXXIX, 1905, p. 403.) The figure of the bird humerus, given by Parsons, strikingly resembles the ossificatory plan in the plesiosaurs, save that the latter in the early stage has perforating canals through the rudimentary medulla. These observations of Parsons, seen by me for the first time since the above was in type, effectually dispose of the whole matter of turtle relationships in the manner of ossification of the long bones.

wanting in the turtles. The turtles have a single, unpaired, true vomer and no prevomers; the sauropterygians have large prevomers and a small or no true vomer. A large interpterygoid vacuity is present in the plesiosaurs, wanting in the turtles. Furthermore, the turtles have still preserved the primitive hypocentral mode of attachment of the thoracic ribs, while the single-headed thoracic ribs of the plesiosaurs are attached high up on the extremities of the diapophyses, and this character can not be ascribed to aquatic adaptation, I think, since the ichthyosaurs and mosasaurs have preserved their early pleurocentral attachment of these ribs.

And one is welcome to all the resemblances that may be found in the vertebræ, girdles, and limbs. I repeat, there is only a remote relationship between the two orders in osteological structure. The plesiosaurs could not have been derived from any ancestors that might by the widest stretch of imagination be called Chelonia, or Chelonia-like. Nor could the turtles have come from any forbears even suggesting the sauropterygian structure.

I am still strongly of the opinion that the Sauropterygia were derived from a primitive therocephalian ancestry; while I am firmly of the opinion that the turtles have had a quite independent origin from some primitive cotylosaurian, like the Chelydosauria, as Case has forcefully shown. The turtles occupy a phylum distinctly their own, no more intimately related to the plesiosaurs than they are to the ichthyosaurs or rhynchocephalians. I can not accept the contention of McGregor that the Ichthyosauria had a primitively saurocrotaphous (I need not apologize for the word) type of skull, but would rather believe that they, too, enjoyed a genealogical line all their own from the most primitive type of reptiles, and that they should no more be grouped with the dinosaurs and crocodiles than with the plesiosaurs and theriodonts.

EXPLANATION OF PLATES.

PLATE XXXIV.

Brachauchenius lucasi, type specimen in U. S. National Museum. After Lucas. (Plate from Vol. I, Quarterly, Smithsonian Misc. Col.)

PLATE XXXV.

Skull of *Brachauchenius*, U. S. National Museum Collection, from Eagle Ford Shales of Texas. One-fourth natural size. *Exo*, exoccipital; *Pet*, petrosal; *St*, stapes.

PLATE XXXVI.

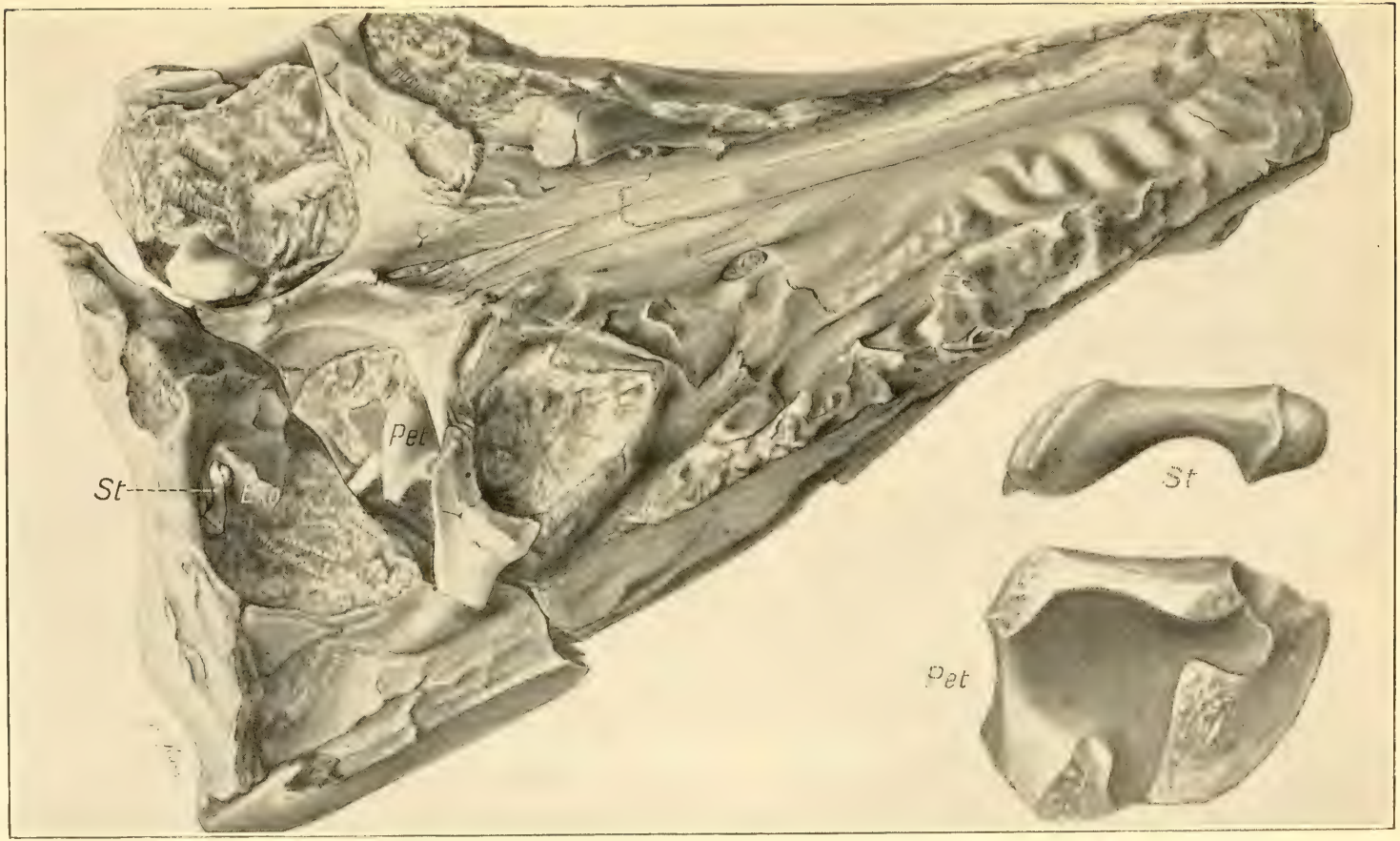
Part of front paddle of *Brachauchenius*, Texas specimen, one-half natural size.

PLATE XXXVII.

Restored outline of skull of *Brachauchenius*, Texas specimen, one-half natural size. *Ang*, angular; *Ep*, epipterygoid; *Fr?*, frontal; *Na?*, nasal?; *J*, jugal; *La*, lachrymal; *max*, maxilla; *na*, external naris; *Pa*, parietal; *Pf*, parietal foramen; *Pfr*, postfrontal; *Po*, postorbital; *Prf*, prefrontal; *Pmx*, premaxilla; *Q*, quadrate; *Sq*, squamosal; *Sur*, surangular; *Tv*, temporal vacuity.

BRACHAUCHENIUS LUCASI. TYPE SPECIMEN.

FOR EXPLANATION OF PLATE SEE PAGE 489.

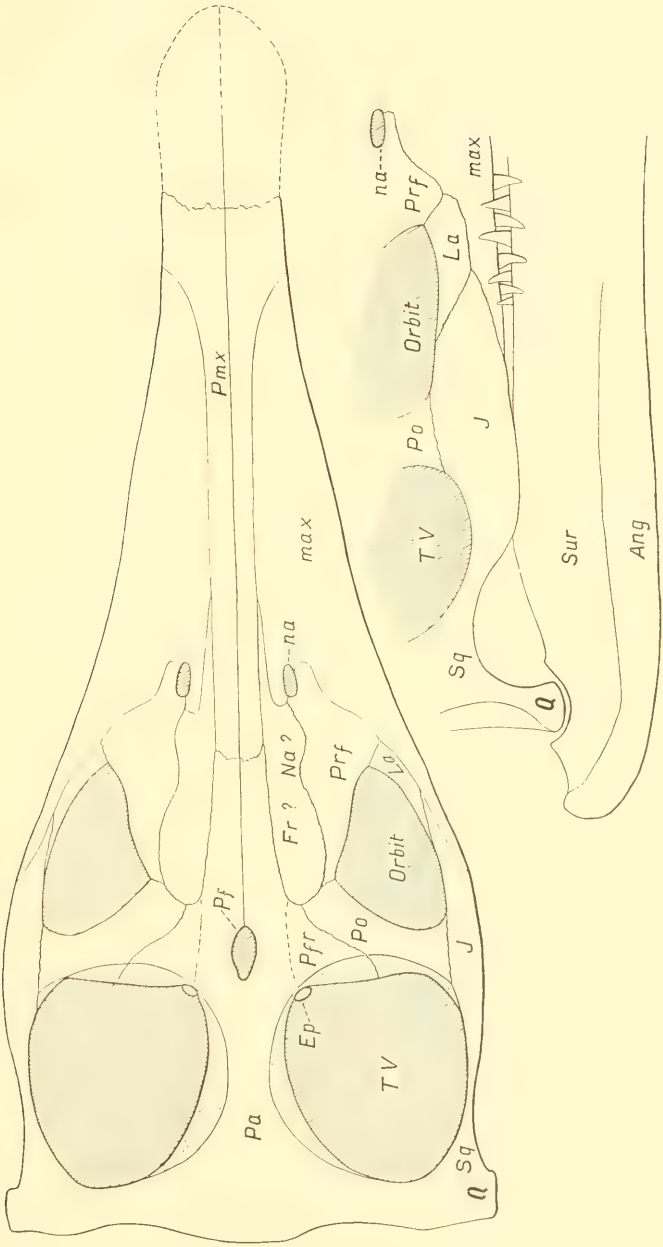


SKULL OF BRACHAUCHENIUS, FROM EAGLE FORD SHALES OF TEXAS.

FOR EXPLANATION OF PLATE SEE PAGE 489.

PART OF FRONT PADDLE OF BRACHAUCHENIUS.

FOR EXPLANATION OF PLATE SEE PAGE 489.



RESTORED OUTLINE OF SKULL OF BRACHAUCHENIUS.

FOR EXPLANATION OF PLATE SEE PAGE 489.

LIST OF FISHES RECORDED FROM OKINAWA OR THE RIU KIU ISLANDS OF JAPAN.

By David Starr Jordan and Edwin Chapin Starks,
Of Stanford University.

The Riu Kiu Islands, known also as Lu Chu or Lyu Kyu, in Japanese as Okinawa, constitute a group of tropical islets, coral bound and volcanic in origin, extending southward from near the Japanese island of Kiusiu toward the island of Formosa. Little is known of the fish-fauna of this region, except that it is fully tropical, composed largely of forms having a wide distribution among the coral islands of Polynesia, with some species characteristic of the coasts of southern Japan and China.

While in Japan, in 1900, Messrs. Jordan and Snyder obtained two small but useful collections from these islands. One of these was presented by Mr. Alan Owston, the well-known naturalist of Yokonama; the other was purchased from Yonekichi Koneyama, a natural-history dealer in Tokyo. The first collection was made up of small fishes from the reefs of the large island of Katsuudake, on which is Naha, the principal town of Okinawa, and from the smaller island of Ishigaki at its town of Yaeyama. Koneyama's collection came from the Naha market. From the Imperial Museum of Tokyo also several specimens were received, from the island of Miyako (Miyakojima), and from Naha, island of Katsuudake, through the courtesy of Dr. Chiyomatsu Ishikawa. Some others were received from the Imperial University through Dr. Kakichi Mitsukuri, and still others in the Imperial Museum have been recorded by Ishikawa and Matsuüra.

The collections in question were brought by Profs. Jordan and Snyder to the Museum of Stanford University, and most of the new species have been already noted in previous papers on the fish-fauna of Japan. A series of duplicates is in the United States National Museum. Illustrations of a number of these species have appeared in papers recently published in these Proceedings.

Family CHANIDÆ.

Chanos chanos (Forskål).

Okinawa (Imperial Museum).

Family ELOPIDÆ.

Megalops cyprinoides (Broussonet).

Okinawa (Koneyama).

Elops saurus Linnæus.

Okinawa (Imperial Museum).

Family SYNODONTIDÆ.

Synodus japonicus (Houttuyn).

Okinawa (Imperial Museum).

Family MONOPTERIDÆ.

Monopterus albus (Zuieuw).

Monopterus albus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 838.

Naha, Amami-Oshima (Owston).

Family LEPTOCEPHALIDÆ.

Leptocephalus riukiuanus (Jordan and Snyder).

Leptocephalus riukiuanus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 852.

Ishigaki (Owston).

Family MYRIDÆ.

Muræniehthys owstoni (Jordan and Snyder).

Muræniehthys owstoni JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 862.

Ishigaki (Owston).

Family OPHICHTHYIDÆ.

Callechelys melanotænia (Bleeker).

Callechelys melanotænia JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 865.

Ishigaki (Owston).

Leiuranus semicinctus (Lay and Bennett).

Leiuranus semicinctus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 866.

Ishigaki (Owston).

Chlevastes colubrinus (Boddært).

Chlevastes colubrinus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 867.

Ishigaki (Owston).

Microdonophis erabo (Jordan and Snyder).

Microdonophis erabo JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 870.

Naha, Okinawa (Koneyama).

Family MORINGUIDÆ.

Moringua abbreviata (Bleeker).

Aphthalmichthys abbreviatus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 877.

Ishigaki (Owston).

Family MURÆNIDÆ.

Strophidon brummeri (Bleeker).

Strophidon brummeri JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 885.

Ishigaki (Owston).

Echidna delicatula (Bleeker).

Echidna kishinouyei JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1901, p. 885.

Naha, Okinawa (Koneyama).

Uropterygius okinawæ (Jordan and Snyder).

Uropterygius okinawæ JORDAN and SNYDER, Proc. U. S. Nat. Mus., 1901, p. 887.

Okinawa (Koneyama).

Family EXOCŒTIDÆ.

Hemiramphus dussumieri (Cuvier and Valenciennes).

Okinawa (Imperial Museum).

Family SYNGNATHIDÆ.

Corythroichthys isigakius JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 7.

Ishigaki (Owston.)

Gasterotokeus biaculeatus (Bloch).

Gasterotokeus biaculeatus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 11.

Miyako Island (Imperial Museum).

Hippocampus aterrimus (Jordan and Snyder).

Hippocampus aterrimus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 14.

Ishigaki (Owston).

Hippocampus kuda (Bleeker).

Hippocampus kuda JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 15.

Miyako (Imperial Museum).

Family CENTRISCIDÆ.

Æoliscus strigatus (Günther).

Æoliscus strigatus JORDAN and STARKS, Proc. U. S. Nat. Mus., XXVI, 1903, p. 71.

Ishigaki Island (Owston).

Family ATHERINIDÆ.

Atherina woodwardi (Jordan and Starks).

Atherina woodwardi JORDAN and STARKS, Proc. U. S. Nat. Mus., XXIV, 1902, p. 200.

Okinawa, Miyako (Imperial Museum; Imperial University.)

Family MUGILIDÆ.

Liza troscheli (Bleeker.)

Okinawa (Imperial Museum).

Family HOLOCENTRIDÆ.

Holocentrus praslin (Lacépède).

Holocentrus alboruber JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXVI, 1903, p. 15.

Naha, Okinawa (Imperial Museum).

This specimen represents the highly colored form or ontogenetic species common also in the coral reefs of Samoa, and throughout the South Seas. This is *Holocentrus praslin* (Lacépède). It differs from the typical *Holocentrus ruber* (Forskål) (*H. alboruber*) only in its intense colors, the deep red stripes being almost black. *H. alboruber* from Canton seems to be the same as *H. ruber* of the Red Sea.

Holocentrus ittodai (Jordan and Fowler).

Holocentrus ittodai JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXVI, 1903, p. 16.

Naha, Okinawa (Imperial Museum).

Family CARANGIDÆ.

Scomberoides orientalis (Schlegel).

Miyako (Imperial Museum).

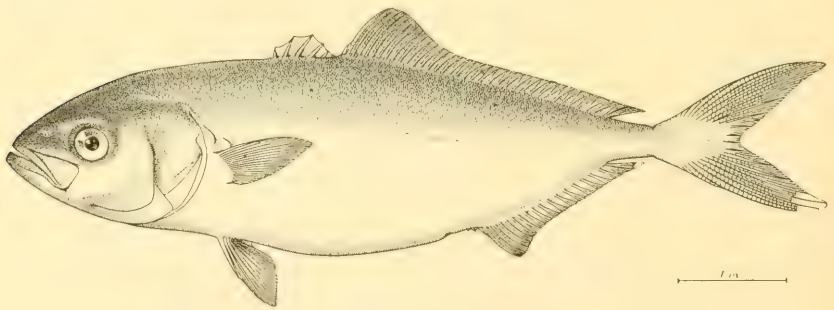


FIG. 1.—SERIOLA QUINQUERADIATA.

Caranx ignobilis (Forskål).

Miyako (Imperial Museum).

Seriola quinqueradiata (Schlegel).

Two specimens from Naha (Imperial University).

Trachinotus bailloni (Lacépède).

One specimen from Naha, a little deeper in form than usual in this species (Imperial University).

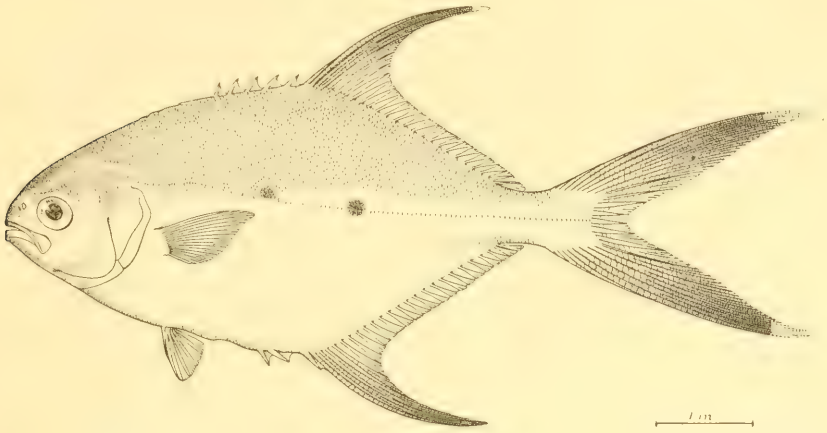


FIG. 2.—TRACHINOTUS BAILLONI.

Family EQUULIDÆ.

Leiognathus edentulus (Bloch).

Miyako.

Family SERRANEIDÆ.

Epinephelus merra (Bloch).

Okinawa (Imperial Museum).

Epinephelus fasciatus (Forskål).

Okinawa (Imperial Museum).

Cephalopholis urodelus (Cuvier and Valenciennes).

Okinawa.

Centrogenys waigiensis (Quoy and Gaimard).

Okinawa (Imperial Museum).

Family LUTIANIDÆ.

Lutianus marginatus (Cuvier and Valenciennes).

Okinawa (Imperial Museum).

Lutianus unimaculatus (Bloch).

Okinawa (Imperial Museum).

Terapon jarbua (Forskål).

Okinawa (Imperial Museum).

Family MULLIDÆ.

Pseudupeneus indicus (Shaw).

Pseudupeneus indicus SNYDER, Proc. U. S Nat. Mus., XXXII, 1907, p. 93.

Okinawa (Imperial Museum).

Pseudupeneus moana (Jordan and Seale).

Pseudupeneus moana SNYDER, Proc. U. S. Nat. Mus., XXXII, 1907, p. 89.

Okinawa (Imperial Museum).

Family KYPHOSIDÆ.

Girella Mezina Jordan and Starks, new species.

Head $3\frac{2}{5}$ in length to base of caudal; depth $2\frac{1}{6}$. Eye $3\frac{1}{2}$ in head; maxillary 3; interorbital space $3\frac{2}{3}$. Dorsal XIV, 14; anal III, 11; scales 8–50–17, besides smaller ones.

Jaws equal, maxillary reaching to below front of eye. Interorbital space broad and convex; outline of head a little more convex opposite eyes than elsewhere. Preopercle very finely denticulate, the spinules extending around the angle but not much on the lower limbs. Gill-rakers slender; 22 on lower limb of arch; the longest one-third of diameter of orbit.

Scales strongly ctenoid; 7 scales in a series extending down and back between front of dorsal and lateral line, 17 up and forward from front of anal to lateral line. Small scales on the basal three-fourths of soft dorsal, caudal, and anal, between the rays. Small scales closely cover the cheek, opercle, and subopercle; a narrow row of scales along upper edge of interopercle; no naked area anywhere on opercle or subopercle. Small crowded scales covering interorbital space extending to a blunt point at middle of space a little anterior to middle of eye, leaving supraorbital rim naked. Snout, preorbital, maxillary, and mandible naked.

No notch between dorsals; the last dorsal spine the longest, equal to distance from tip of snout to edge of preopercle. Second anal spine as long as third and somewhat stronger; its length two-thirds that of soft rays. Ventrals reaching to vent; pectoral bluntly pointed at tips of upper rays; caudal lunate.

Color light brown, doubtless dark olive green in life, made dark by a dark brown spot at the base of each scale; upper parts of side darker; belly light brown; under part of head white; a conspicuous yellowish-white bar extends across sides from base of seventh and eighth dorsal spines toward vent, but scarcely reaching to vent; its width is about half that of eye. Dorsal and anal and ventral dark brown, the last darker on upper surface; pectoral dusky brown with a brown streak across its base.

This species differs from *Girella zonata* Günther, a species from an unknown locality, in having the opercular bones closely scaled. In

all other respects it agrees very well with Günther's description. In *Girella zonata*, the opercle is said to be naked, with scales on its upper margin only, the usual condition in the genus *Girella*.

Mr. C. Tate Regan, at our request, has examined the type of *Girella zonata* in the British Museum, as also two young examples of the same species from Porto Grande, St. Vincent, collected by the Travailleur and Talisman.

These agree with Dr. Günther's account, having scales, comparable to those on the cheeks, on the upper part of the opercle only. The rest of the opercle is covered by smooth skin, in which minute rudimentary scales can be detected.

Girella zonata is therefore a species distinct from *Girella mezina*, and its habitat is in the eastern Atlantic.

The Japanese species may be distinguished by the following:

KEY TO SPECIES.

a. Opercles naked, except for a band of scales above; no white cross band; lobes of caudal acute.

b. Dorsal species XV; scales about 8–52 to 53–17; color not very dark, a dark spot at the base of each scale along side of body; edge of opercle pale ..*punctata*.

bb. Dorsal species XIV; scales about 10–62–18, besides smaller ones; color very dark; no distinct spots at base of scales; edge of opercle dusky.....*leonina*.

aa. Opercles fully scaled; scales about 8–50–17; dorsal species XIV; body rather deep; color brown, with a darker spot at base of each scale; a conspicuous cross bar of yellowish white on middle of body extending nearly to vent; lobes of caudal bluntish.....*mezina*.

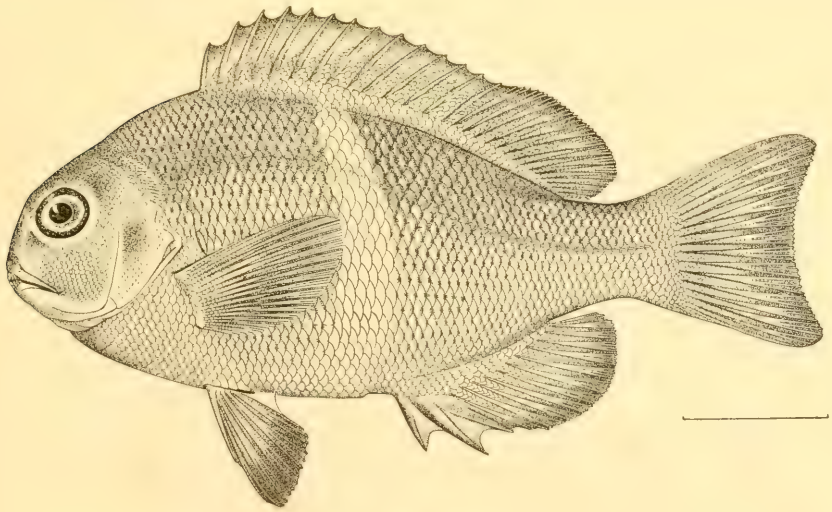


FIG. 3.—GIRELLA MEZINA.

Girella mezina is here described from a specimen 150 mm. in length taken at Naha, and presented by the Imperial University. It is numbered 9985, Stanford University. *Mejina* or *Mejinadai* is the vernacular name of *Girella punctata* in Japan.

In the Japanese collections of Jordan and Snyder we find specimens of two other species of *Girella*. One of these, the common Mejina of the markets, is unquestionably the *Girella punctata* of Gray. This is a large scaled form, having 50 to 52 series of scales, usually 15 dorsal spines (in one specimen we find but 14). The membrane

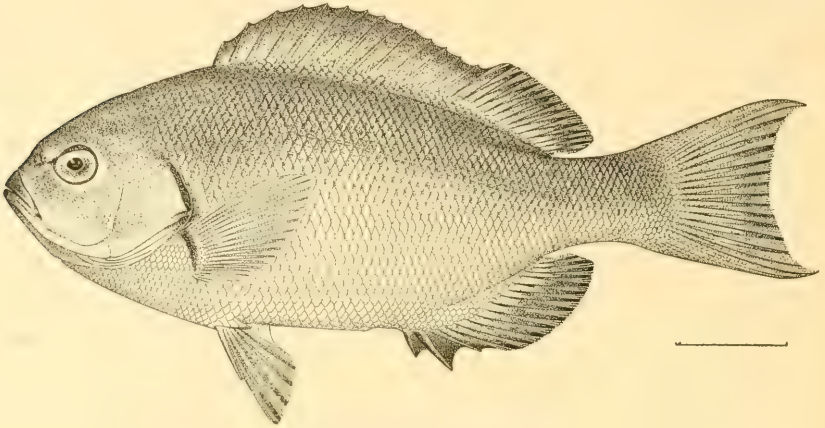


FIG. 4.—GIRELLA LEONINA.

of the gill cover is pale; the general color is olive, darker on the fins, and each scale has a faint darker spot at base. The other is *Girella leonina*, *Crenidens leoninus*, and *Crenidens melanychthys* of Richardson, the latter based on the figure of *Melanychthys* of Schlegel.

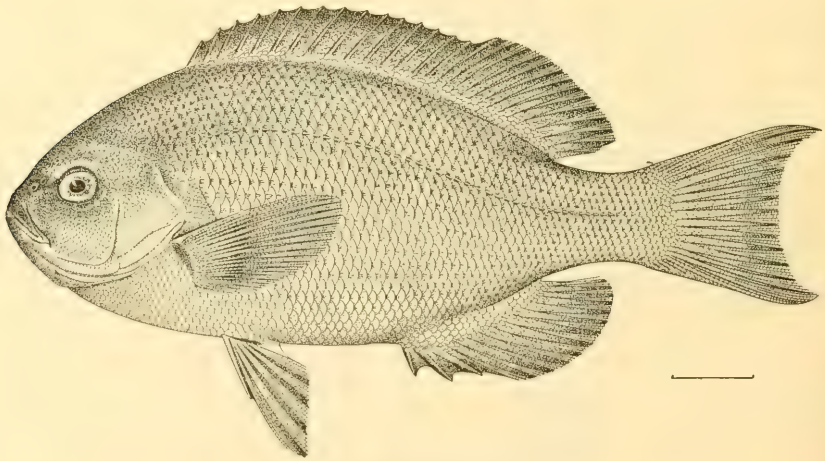


FIG. 5.—GIRELLA PUNCTATA.

In this species there are 60 series of scales, 14 dorsal spines; the scales are dark without darker basal spot and there is a dark brown border to the gill cover. Of *Girella punctata* we have specimens from Wakanoura, Tokyo, Yokohama, Nagaski, Misaki, and Tsuruga. We figure a specimen from Yokohama. Of *Girella melanichthys*

we obtained a single specimen from Wakanoura. The figure of "*Melanychthys*" Schlegel, shows this second species, but the opercles are represented in the figure as entirely scaly, a condition which obtains in *Girella mezina* but in neither of the other Japanese species. In both these species, *Girella punctata* and *Girella leonina*, there are scales along the upper part only of the opercle.

Of the two names given by Richardson, *leoninus* and *melanichthys*, the latter can be certainly identified, as it rests on the illustration by Schlegel.

Crenidens leoninus occurs on a preceding page, and has therefore page priority. It is based on a figure of Reeves. The scanty description gives the number of dorsal species as 14, and the coloration plain dark green and reddish with no mention of spots.

The name *leoninus*, therefore, without much doubt belongs to the species called *Melanychthys* by Schlegel.

Family GERRIDÆ.

GERREOMORPHA JAPONICA (Bleeker).

Two specimens from Okinawa presented by the Imperial University. We have also a specimen similar to these from Wakanoura. This species much resembles the common Japanese *Xystæma erythrourum* (Bloch) (=*Gerres equula* Schlegel). It is, however, distinguished by small but constant differences, besides the distinction in the number of dorsal spines on which Macleay founded the genus, *Gerreomorpha japonica* have 10 dorsal spines, while in all the species of *Gerres* and of *Xystæma* there are nine.

The body in *Gerreomorpha japonica* is deeper than in *Xystæma erythrourum*, the depth $2\frac{1}{2}$ in length to base of caudal. In *X. erythrourum* the depth is $2\frac{3}{4}$ in length. The anterior curves of the outline in *G. japonica* are more convex, and the body more angulated at front of anal. There is a little less distance between the ventral base and the anal spines. In *G. japonica* the distance from front of ventral base to anal spines is equal to the distance from tip of snout to base of pectoral. In *X. erythrourum* the former distance is greater by nearly an eye's diameter. The snout, in *G. japonica* is a little shorter less than eye, while in *X. erythrourum* it is slightly greater than eye. The dorsal rays in *Gerreomorpha japonica* are X, 9; in *Xystæma erythrourum*, IX, 10.

The second interhæmal in *X. erythrourum* is long and spear-shaped as in the American *Xystæma cinereum*. The air bladder is forked behind, a fork on each side of the interhæmal spine.

Gerreomorpha japonica has been hitherto known from a single specimen obtained by Doctor Bleeker at Nagasaki and from a specimen from Nagasaki described by Nyström.[a]

[a] Svensk. Vet. Akad. Handl., 1887, p. 12.

The species from China called *Gerres japonicus* by Günther, having nine dorsal spines and the depth 2¾ inches high, must be a *Xystæma*, probably *X. erythrourum*. Of this species we have many specimens from Wakanoura, Oida, and Nagasaki.

Family POMACENTRIDÆ.

Amphiprion frenatus (Brevoort).
Amphirion frenatus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 597.

Abudefduf cœlestinus (Lacépède).

Okinawa (Imperial Museum).

Family LABRIDÆ.

Crenilabrus stejnegeri (Ishikawa).
Crenilabrus stejnegeri ISHIKAWA, Proc. Imperial Museum, Tokyo, 1904, p. 12, Naha, Okinawa.

Okinawa (Imperial Museum).

Ampheces geographicus (Cuvier and Valenciennes).
Anampses geographicus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 628.

Okinawa (Imperial Museum).

Stethojulis psacas (Jordan and Snyder).
Stethojulis psacas JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 629.

Okinawa (Imperial Museum).

Stethojulis strigiventer (Bennett).
Stethojulis strigiventer JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 631.

Miyako (Imperial Museum).

Hemigymnus melapterus (Bloch).
Hemigymnus melapterus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 634.

Okinawa (Imperial Museum).

Halichæres trimaculatus(Quoy and Gaimard).
Güntheria trimaculata JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 635.

Okinawa (Imperial Museum).

Cheilio inermis (Forskål).
Cheilio inermis JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 644.

Naha, Okinawa (Imperial Museum).

Thalassoma lutescens (Solander).
Thalassoma lutescens JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 647.

This species is apparently well separated from *Thalassoma lunare*. It occurs also in the South Seas.

Thalassoma dorsale (Quoy and Gaimard).
Thalassoma dorsale JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 648.

Okinawa (Imperial Museum).

Gomphosus tricolor (Quoy and Gaimard).
Gomphosus tricolor JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 649.

Naha, Okinawa (Imperial Museum).

Gomphosus varius (Lacépède).
Gomphosus varius JORDAN and SNYDER, Proc. U. S. Nat .Mus., XXIV, 1902, p. 650.

Cirrhilabrus lyukyuensis (Ishikawa).
Cirrhilabrus lyukyuensis ISHIKAWA, Proc. Imp. Mus., Tokyo, I, 1904, p. 13.

Miyako (Imperial Museum).

Cheilinus oxyrhynchus (Bleeker).
Cheilinus oxyrhynchus JORDAN and SNYDER; Proc. U. S. Nat. Mus., XXIV, 1902, p. 653.

Okinawa (Imperial Museum).

Family SCARICHTHYIDÆ.

Calotomus japonicus (Cuvier and Valenciennes).
Calotomus japonicus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 657.

Okinawa (Imperial Museum).

Family PLATACIDÆ.

Platax teira (Forskål).
Platax teira JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 526.

Okinawa (Imperial Museum).

Family CHÆTODONTIDÆ.

Chætodon vagabundus (Linnæus).
Chætodon vagabundus JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 532.

Naha, Okinawa.

Chætodon setifer (Bloch).
Chætodon setifer JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 531.

Okinawa (Koneyama).

Chætodon dædalma (Jordan and Fowler).
Chætodon dædalma JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 538.

Naha, Okinawa (Koneyama).

Heniochus acuminatus (Linnæus).
Heniochus macrolepidotus JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 542.

Holacanthus tibicen (Cuvier and Valenciennes).
Holacanthus tibicen JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 548.

Naha, Okinawa (Koneyama).

Family ACANTHURIDÆ.

Hepatus triostegus (Linnæus).
Teuthis triostegus JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 552.

Okinawa (Imperial Museum).

Hepatus matoides (Cuvier and Valenciennes).

Teuthis argenteus JORDAN and FOWLER, Proc. U. S. Nat. Mus. (perhaps not of Quoy and Gaimard), XXV, 1902, p. 553.

Okinawa (Imperial Museum).

This species is the one figured by Jenkins as *Teuthis güntheri*. The rest of its synonymy is uncertain, but the name *matoides* probably belongs to it.

Hepatus elongatus (Lacépède).

Teuthis bipunctatus JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 554.

Miyako Island, Okinawa (Imperial Museum). This is identical with *Acanthurus nigroris* Cuvier and Valenciennes and with *Acanthurus bipunctatus* Günther.

Zebrasoma flavescens (Bennett).

Zebrasoma flavescens JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 555.

Naha, Okinawa (Koneyama).

Family SIGANIDÆ.

Siganus virgatus (Cuvier and Valenciennes).

Siganus virgatus JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 562.

Miyako (Imperial Museum).

Family BALISTIDÆ.

Balistes capistratus (Shaw).

Pachynathus capistratum JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 255.

Naha (Koneyama).

Balistes flavimarginatus (Rüppell).

Pseudobalistes flavimarginatus JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 257.

Okinawa (Imperial Museum).

Balistapus aculeatus (Linnæus).

Balistapus aculeatus JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 259.

Naha (Koneyama).

Monacanthus setifer (Bennett).

Miyako (Imperial Museum).

Family TETRAODONTIDÆ.

Spheroides alboplumbeus (Richardson).

Spheroides alboplumbeus Jordan and Snyder, Proc. U. S. Nat. Mus., XXIV, 1902, p. 243.

Okinawa (Imperial Museum).

Tetraodon hispidus (Linnæus).

Tetraodon hispidus Jordan and Snyder, Proc. U. S. Nat. Mus., XXIV, 1902, p. 251.

Naha (Koneyama); Ishigaki Island (Owston).

Tetraodon meleagris (Lacépède).

Tetraodon meleagris Jordan and Snyder, Proc. U. S. Nat. Mus., XXIV, 1902, p. 253.

Okinawa (Koneyama).

Family CHEILODACTYLIDÆ.

Goniistius zonatus (Cuvier and Valenciennes).

Okinawa (Imperial Museum).

Family SCORPÆNIDÆ.

Scorpænopsis gibbosa (Bloch).

Okinawa (Imperial Museum).

Pterois volitans (Linnæus).

Miyako (Imperial Museum).

Family OSPHROMENIDÆ.

Polyacanthus opercularis (Linnæus).

Okinawa (Imperial Museum).

Family GOBIIDÆ.

Valenciennea muralis (Quoy and Gaimard).

Valenciennea muralis Jordan and Snyder, Proc. U. S. Nat. Mus., XXIV, 1902, p. 42.

Miyako (Imperial Museum).

Rhinogobius nebulosus (Forskål).

Gobius criniger Cuvier and Valenciennes.

Okinawa (Imperial Museum).

Eleotris fusca (Bloch and Schneider).

Eleotris fusca JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIV, 1902, p. 45.

Synonymy, not description, which was taken from a Hawaiian example of *Eleotris sandwichensis* Vaillant and Sauvage.

Okinawa (Imperial Museum).

Family BLENNIIDÆ.

Petroscirtes elatus (Jordan and Snyder).

Petroscirtes elatus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXV, 1903, p. 452.

Ishigaki Island (Owston).

Salarias fasciatus (Block).

Salarias ceramensis JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXV, 1903, p. 458.

Ishigaki Island (Owston). This is probably *S. ceramensis* of Bleeker.

Family CONGROGADIDÆ.

Congrogadus subducens (Richardson).

Hierichthys encryptes JORDAN and FOWLER, Proc. U. S. Nat. Mus., XXV, 1902, p. 744.

Miyako.

The genus *Hierichthys* is not distinct from *Congrogadus*, the continuous lateral line shown in Richardson's figures of *Congrogadus subducens* being due to an error of the artist, as Richardson himself observed. This correction on the part of Richardson was overlooked when the genus *Hierichthys* was proposed.

A NEW GERRHONOTINE LIZARD FROM COSTA RICA.

By Leonhard Stejneger,

Curator, Division of Reptiles and Batrachians, U. S. National Museum.

Prof. A. Alfaro, the distinguished director of the National Museum in San José, Costa Rica, has sent me from time to time specimens of reptiles for identification, and among them is a *Gerrhonotus* which appears to be new, and which I take pleasure in naming after him.

GERRHONOTUS ALFAROI, new species.

Diagnosis.—An unpaired prefrontal shield laterally inclosed by two pairs of prefrontals, and narrowly in contact with frontal; dorsal scales not larger than ventrals; nuchal scales in 8 rows; lateral dorsal scales smooth; dorsal scales in 16 rows, the 6 median rows strongly keeled; 2 pairs of internasals; nasal not in contact with rostral; no projecting scales above the ear; ventrals in 12 rows. Color above black, sprinkled with numerous bluish (greenish?) specks.

Habitat.—Costa Rica.

Type.—Cat. No. 37342, U.S.N.M.; Santa Maria, northeast Laguna, Costa Rica, 2,000 meters altitude; January, 1907; collector, J. F. Tristan; original No. 223.

Description of type-specimen.—Head very distinct from neck; head shields smooth; 2 pairs of internasals behind the rostral; 5 prefrontals, 2 smaller ones on each side of a large, unpaired, hexagonal shield, the latter narrowly in contact with the frontal; nasal separated from rostral; 2 small supranasals; 1 postnasal, much higher than broad; 2 superposed loreals, upper largest, extending to the upper surface; 4 smaller outer supraoculars, anterior largest, and 4 larger inner ones, anterior 2 in contact with frontal; frontal broadly in contact with interparietal; 1 pair of fronto-parietals and 2 pairs of parietals, the anterior pair larger and separated by interparietal, the posterior by the occipital; 9 supralabials, the last largest and larger than temporals; sides of neck widely granular; lateral fold strong, with a granular zone; nuchal scales smooth, in 8 rows; dorsals not

larger than ventrals, in 16 rows, the 6 median rows strongly keeled, the next row on each side feebly keeled, the others smooth; 46 transverse dorsal rows between occiput and level of vent; ventrals in 12 longitudial rows; limbs scarcely meeting when pressed against the side. Color (in alcohol) above shiny black, with a purplish mother-of-pearl gloss in a certain light, densely speckled with minute spots of a pale greenish blue, 2 or more spots on each scale and shield; underneath bluish gray, densely spotted with black.

Dimensions.	*mm.*
Total length	201
Snout to ear-opening	17
Snout to posterior end of occipital	15
Greatest width of head	12
Snout to vent	82
Vent to tip of tail	119
Axilla to groin	48
Fore leg	21
Hind leg	27

Remarks.—This new species in style of coloration strongly suggests *Barissia imbricata*, but has otherwise nothing in common with it. Its relationship is rather with *Gerrhonotus moreletii* and *G. monticolus*, but it differs from both in many important particulars besides the coloration. The latter species, of which I have the type specimen before me (Cat. No. 30591, U.S.N.M.), is easily distinguished by its nearly smooth dorsal scales, only those on the lower back being obscurely keeled. *G. moreletii* appears to differ in the smaller dorsals which form several more rows, both longitudinal and transverse, in the greater number of labials, and in the lesser extent of the granular space on the side of the neck.

TWO NEW CRINOIDS FROM THE NORTH PACIFIC OCEAN.

By Austin H. Clark,

Of the United States Bureau of Fisheries.

The remarkable crinoid which is described below was obtained by the U. S. Fisheries steamer *Albatross* on August 30, 1906, in 33° 23′ 30″ north latitude, 135° 34′ 00″ east longitude, Shio Misaki light, south coast of Nipon, Japan, bearing N. 75° E., 9.6 miles distant, the station being No. 4971. The bottom temperature was 38.1° F. (corrected), the depth 649 fathoms, with a bottom of brown and green mud, with numerous foraminifera.

PHRYNOCRINUS Clark, new genus.

The characters of this genus are included in the diagnosis of the type species as follows:

Type of the genus.—*Phrynocrinus nudus* Clark.

PHRYNOCRINUS NUDUS Clark, new species.

Type.—Cat. No. 22601, U.S.N.M.

The general aspect of the calyx is quite different from that in any known crinoid. In shape it is somewhat like an acorn, expanding rapidly from the top of the stem to about the fourth radial, where it attains a maximum width of 29 mm., gradually becoming narrower again in the region of the axillaries. Probably in life, however, the sides of the calyx are parallel or slightly diverging from the fourth radial upward. The most characteristic feature of the calyx is the broad naked space between the radials, which is equal in width to twice the diameter of the radials themselves, and is covered with a tough, leathery integument, in which as yet I have not succeeded in making out any interradial plates whatever, although they may occur deeply embedded in the skin. The radials are small, and are subequal in size, the largest being the fourth or fifth in each arm, from which point the size diminishes in each direction; their number is very large, in one arm 18, including 7 syzygies, so that the total number of individual joints is 25. The radials radiate out from the very small basals,

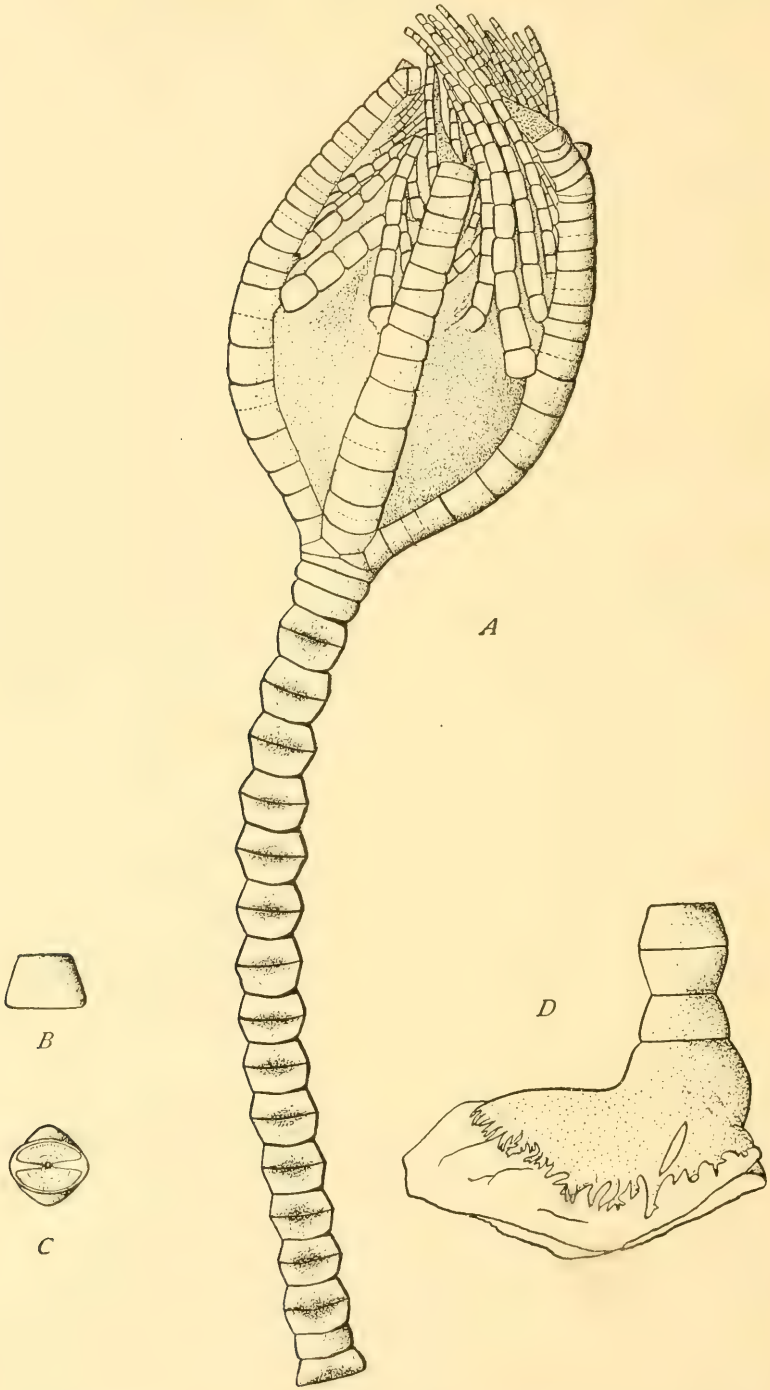


FIG. 1—PHRYNOCRINUS NUDUS. *A*, CALYX AND UPPER STEM JOINTS; *B*, STEM JOINT, LATERAL VIEW; *C*, STEM JOINT, END VIEW; *D*, ROOT AND LOWER STEM JOINTS. ENLARGED ONE-THIRD.

in five narrow lines over the surface of the calyx, widely separated from each other by the interradial integument, which forms two-thirds of the superficial area of the calyx, the radials themselves collectively occupying only about one-third. (See fig. 1.)

The five basals are triangular in shape, 4 mm. long by 2 mm. high, and are in apposition all around (the lateral angles being slightly blunted at the point of contact) except in one place, where 2 adjacent basals do not quite meet, leaving a gap of about $\frac{1}{2}$ mm. They thus form a ring, interrupted in one place, about the lower part of the calyx. The lower (dorsal) edges of the basals are somewhat convex, giving the upper edge of the top stem joint a scalloped appearance.

The five first radials are practically equal in size, 5 mm. wide by 2.5 mm. high, and are produced dorsally into a shallow V where they enter the interbasal spaces. Each first radial is in close apposition to those on each side of it along its entire lateral edge, the five therefore forming a continuous ring about the base of the calyx. The outer surface of these, as of all the radials, is strongly convex, a cross section being practically a semicircle. The succeeding radials all have practically parallel sides, and are (the radials of the separate rays) separated from each other by a broad expanse of tough, leathery integument, equal in width in each interradial area to about twice the width of the radials as far down as the fifth or fourth radial, then rapidly converging, forming a V, the apex of which rests on an interradial suture of the first row of radials. The first and second radials are 5 mm. in width; distally the width increases slightly, reaching a maximum of 6 mm. on the fourth or fifth, then gradually decreasing again to 4 mm. on the sixteenth. The radials number from 12 to 18 (including the first axillaries), syzygies being distributed as follows: on one arm the second, fourth, sixth, tenth, twelfth, fifteenth, and nineteenth (axillary); on another the second, fourth, and twelfth; on another the second (a double syzygy of 3 components), fourth, sixth, ninth, eleventh, and fourteenth (axillary); on another the second, fourth, sixth, eighth, and eleventh, and on the last (arm broken off before the first axillary) the second, fourth, and eighth.

The proximal pinnules are 33 mm. in length, or about equal to the distance from the basals to the first axillary, in the arm having the maximum number of radials. They are at the base nearly the diameter of the first brachials (3 mm.), tapering gradually to a point, the number of joints being about 20. The first pinnule is given off as follows: on the right side of the sixth radial (the epizygal of a syzygy), on the right of the sixth radial (not a syzygy), on the left of the fifth radial (not a syzygy), on the left of the epizygal of the sixth radial, and on the left of the sixth radial (not a syzygy). The palmar pinnules are about 6 mm. in length, 1 mm. thick at the base, tapering gradually to a point, and are composed of about 20 joints.

The arms are all detached from the calyx and badly broken up; as nearly as I can judge they appear to branch twice, and occasionally three times. The axials and the second joint after each axial are usually syzygies; other syzygies are distributed at intervals of two, three, or four joints throughout the distichals and palmars. All the joints in the arms are dorsally and laterally somewhat concave, producing a bulging at the articulations, and giving a rough look and feeling to their dorsal surface.

The highly calcarious, hard, and rigid stem is composed of 106 joints, without any trace of nodes or cirri. Each joint is trapezoidal when viewed laterally, the base up when viewed in one position, the base down when viewed in a position at right angles to the first. This is due to the fact that the faces of each joint are elliptical in shape, with the axes of the ellipses of the superior and inferior faces at right angles to each other. The stem is 375 mm. in length, the lowest joint having for each face a maximum diameter of 8 mm. and a minimum diameter of 6 mm., with a height of 4.5 mm., the joints becoming gradually smaller, so that the topmost but one measures—longest diameter 6 mm., shortest diameter 5 mm., height 2 mm. The stem is quite uniform throughout, the only exception being the thirty-second joint from the calyx, which has the axes of both faces running in the same direction instead of at right angles to each other. After the one hundred and sixth joint, which differs from all the others in having its inferior face circular, the diameter of the circle equaling the greater diameter of the ellipse forming its superior face, the stem terminates in a solid, heavy, and very hard root, with a fringe of short radial processes, the whole being firmly attached to a small piece of pumice. The color in life is dull greenish yellow.

Many other features of this strange form are of great interest, but would be out of place in a preliminary description. I hope, however, to be able to publish a detailed account of it later, with a sketch of its anatomy, and a discussion of its probable affinities. It appears to represent an entirely new family, which may appropriately be called "Phrynocrinidæ."

BATHYCRINUS PACIFICUS Clark, new species.

Type.—Cat. No. 22602, U.S.N.M.

It is with great pleasure that I am able to add the genus *Bathycrinus* to the fauna of the abyssal Pacific, as the genus has hitherto only been known from the Atlantic, where, however, it has a very wide range, from 65° 55′ north latitude to 46° 46′ south latitude, through more than 110° of latitude. The discovery of a species in the Pacific gives this genus the most extensive range of all the genera of recent stalked crinoids. No specimen of *Bathycrinus* up to the present time has been obtained in less than 1,050 fathoms of water; the type

of *B. pacificus* was taken in 905 fathoms, 145 fathoms less than the previous record.

The individual described was taken on August 31, 1906, at U. S. Fisheries steamer *Albatross* station No. 4974, in 33° 18′ 10″ north latitude, 135° 40′ 50″ east longitude, Shio Misaki light, south coast of Nipon, Japan, bearing N. 25° E., 8.7 miles distant, being within a few miles of the locality where, on the previous day, the remarkable *Phrynocrinus nudus* was secured. The depth was 905 fathoms, the bottom brown and green mud, with numerous foraminifera, and the bottom temperature 36.6° F. (corrected).

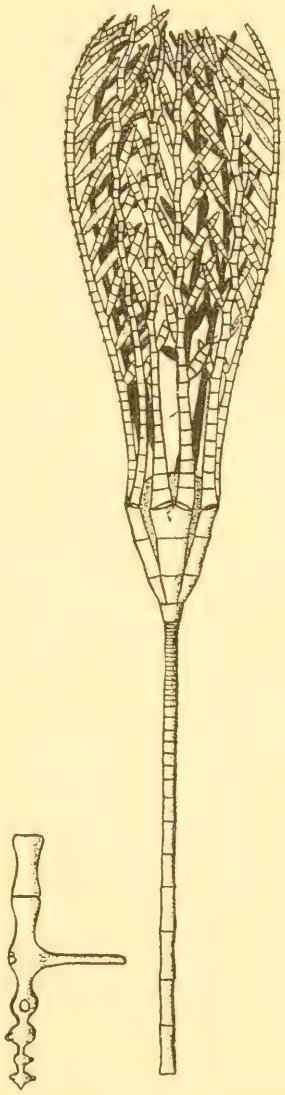


FIG. 2.—BATHYCRINUS PACIFICUS. CROWN AND ROOT. THREE TIMES NATURAL SIZE.

Basals united into a smooth ring, slightly wider above than below, where it is of the same diameter as the upper stem joints; on its upper surface rests the funnel-shaped cup composed of the united radials, resembling most nearly that of *B. aldrichianus*, but when viewed from the side more regularly trapezoidal (the short sides of the trapezoid with no trace of constriction) and when viewed from below less scalloped and more rounded, with the sutural lines less depressed. The radial cup is slightly less in height than the second radial, but slightly more than the third (axillary). In *B. aldrichianus* and *B. campbellianus*, the nearest related species, it is slightly less than either. The second and third radials are trapezoidal in form, widening from below upward, about as in *B. campbellianus;* a low rounded ridge extends down their median line, bifurcating just before the axillary joint, but is much less marked than in the other species. The sharp edges of the axillaries are continued for 3 or 4 joints onto the brachials, after which the brachials become more cylindrical in form. The two lowest are approximately square, but from the third on they are rather longer than wide. The first pinnule is usually on the eighth brachial. The arms and pinnules are essentially as in *B. campbellianus*. (See fig. 2.)

The stem contains about 100 joints, ending in a short unbranched (possibly broken) root, about 6 mm. above which is a simple lateral root, and resembles in character that of other members of the genus. The color in life is very light yellow.

This interesting species will be discussed more fully in a paper now in course of preparation on the crinoids of the Pacific.

A REVIEW OF THE LIZARD-FISHES OR SYNODONTIDÆ OF THE WATERS OF JAPAN.

By David Starr Jordan and Albert Christian Herre,
Of Stanford University.

In this paper is given an account of the Japanese species of the family of lizard-fishes or Synodontidæ. It is based on material collected in 1900 by Professors Jordan and Snyder, and series of specimens are in the United States National Museum and in the museum of Stanford University.

Family SYNODONTIDÆ.

Body oblong or elongate, little compressed, with cycloid scales, rarely naked; mouth very wide, the entire margin of upper jaw formed by the long, slender premaxillaries, closely adherent to which are the slender maxillaries, the latter mostly rudimentary or obsolete, never widened at tip; teeth mostly cardiform on both jaws, tongue, and palatines; canines rarely present; large teeth usually depressible; no barbels.

Opercular bones usually thin, but complete; gill membranes separate, free from isthmus; branchiostegals usually numerous; pseudobranchiæ present; gill-rakers tubercular, obsolete, or modified into teeth; no orbitosphenoid or mesocoracoid; lateral line present; dorsal fin moderate, of soft rays only, its insertion median; ventrals rather large, median; pectoral fins small, inserted high; caudal forked, vertebræ numerous, essentially similar; fishes of sandy bottoms in the warm seas; adipose fin present.

In Japan, these fishes are known as *Eso*.

KEY TO GENERA.

a. Synodontinæ. Teeth simple; gape wide; flesh firm.
  b. Teeth on the palatines in a single band on each side.
    c. Snout very blunt, shorter than eye; anal fin longer than dorsal.
      Trachinocephalus, 1.
    cc. Snout rather acute, longer than eye; anal fin much shorter than dorsal.
      Synodus, 2.

bb. Teeth on the palatines in two bands on each side; snout rather acute; anal fin shorter than dorsal.....*Saurida*, 3.

aa. HARPODONTINÆ. Canine teeth of lower jaw barbed; flesh very soft; scales very thin; long teeth more or less depressible; anal fin moderate.

Harpodon, 4.

1. TRACHINOCEPHALUS Gill.

Trachinocephalus GILL, Cat Fish Eastern Coast N. Amer., 1861, p. 53 (*myops*); (name only; first defined in Proc. Acad. Nat. Sci. Phila., 1862, p. 241).

Goodella OGILBY, Proc. Linn. Soc. N. S. W., XXII, 1897, p. 249 (*hypozona*= young of *myops*.)

Body elongate, robust, compressed; head large, deep, laterally compressed, its form much as in the genus *Trachinus;* snout very short, blunt; teeth as in *Synodus*, but more slender, smaller, and closely set; lower jaw projecting; vent well forward, very slightly nearer base of caudal than base of ventrals, under tip of last dorsal ray.

This genus is very close to *Synodus*, from which it differs chiefly in form of head and body and in the relative development of the fins, the anal fin especially being longer than the dorsal and provided with more rays.

A single species known, widely disseminated in the tropical waters of the Atlantic, Pacific, and Indian oceans.

(τραχίνος, trachinus; κεφαλή, head.)

1. TRACHINOCEPHALUS MYOPS (Forster).

OKIESO (OFF-SHORE ESO).

Salmo myops FORSTER in Bloch and Schneider, Syst. Ichth., 1801, p. 421 (St. Helena).

Saurus myops CUVIER, Règne Animal, 2d ed., 1829, p. 268 (after Forster).—GÜNTHER, Cat Fish, V, 1864, p. 398 (Cuba, Jamaica, Japan, Amboyna, Pinang, Mauritius, Port Jackson).—DAY, Fishes of India, p. 503, pl. CXVII, fig. 5 (Madras).—ISHIKAWA, Prel. Cat., 1897, p. 22 (Kagoshima, Bonin Is.).

Synodus myops BLEEKER, Atlas Ichth., VI, p. 153, 1870–1872, pl. CCLXXVIII, fig. 3 (Sumatra, Pinang, Bangka, Bali, Celebes, Batjan, Amboyna, Ceram).

Trachinocephalus myops JORDAN, Proc. U. S. Nat. Mus., XIII, 1890, p. 314.—JORDAN and EVERMANN, Fishes of Hawaiian Islands, Bull. U. S. Fish Comm., XXIII, Pt. 1, 1903 (July 29, 1905), p. 62, fig. 13 (Hilo, Honolulu).

Osmerus lemniscatus LACÉPÈDE, Hist. Nat. Poiss., V, 1803, p. 236 (Martinique; after Plumier).

Saurus truncatus AGASSIZ, Pisc. Brasil, p. 82, 1829, pl. XLV (Brazil).

Saurus limbatus EYDOUX and SOULEYET, Voyage Bonite, Poiss., 1841, p. 199 (Hawaii).

Saurus trachinus TEMMINCK and SCHLEGEL, Fauna Japonica, Poiss., 1842, p. 231, pl. CVI, fig. 2 (Nagasaki).

Trachinocephalus trachinus JORDAN and SNYDER, Proc. U. S. Nat. Mus., XXIII, 1900, p. 350 (Tokyo); Check List, 1901, p. 57 (Yokohama).

Saurus brevirostris POEY, Memorias, II, 1860, p. 385 (Cuba).

Goodella hypozona OGILBY, Proc. Linn. Soc. N. S. W. 1897, p. 250 (New South Wales); young form.

Habitat.—Warm parts of Atlantic and Pacific, on nearly all coasts.

Head 3.5 in length; depth 5; head broad, its width a little less than half its length; depth of head 1.6 in its length; snout equals interorbital space, 1.5 in eye; eye 3 in maxillary; maxillary 1.85 in head; pectoral 2.25 in head; ventral 1; base of anal 3.67 in body; length of depressed dorsal 3.75; D. 13; A. 16; P. 12; V. 8; scales 4–55–5.

Body elongate, compressed, deepest just back of head, tapering gradually backward, with a long tail; head large, compressed laterally, deep, the snout blunt and very short; eye small, high, well forward, the adipose eyelid rudimentary; mouth large, oblique; mandible large, slightly projecting, the profile forming a convex curve to below pectoral; lips thin, teeth in upper jaw exposed; teeth in jaws more or less unequal, in double series; no vomerine teeth; palatines with a single series; tongue free in front, with a triangular patch of depressible teeth and with a single median series extending backward over the basibranchials; nostrils close together, the anterior with a ciliated flap; interorbital space deeply concave; gill openings large, membranes free from isthmus; no gill-rakers, the inner surface of the branchial arches covered with tooth-like asperities; gill filaments short; no pseudobranchiæ; peritoneum silvery.

Scales large, cycloid, 6 rows on cheek; also several on edge of opercle and preopercle; occiput scaly, rest of head bare, with minute rugosities; a broad scaly flap between ventrals; a scaly flap at outer axil of ventral; lateral line slightly decurved at first and then straight to base of caudal.

Origin of dorsal nearer tip of snout than origin of adipose fin by width of interorbital space; origin of anal behind tip of depressed dorsal; anal base long, longer than that of dorsal; caudal deeply forked; pectoral small, not reaching origin of dorsal; ventrals long, reaching beyond base of dorsal, inserted a little before tips of pectorals.

Color in alcohol, pale yellow with irregular longitudinal gray stripes (bluish in life), edged with brownish; silvery yellow below; an oblique black scapular spot; top of head and anterior portion of back mottled with irregular dark streaks and blotches. Fins uniform light yellow, the caudal tipped with blackish.

This fish is not uncommon in the waters of southern Japan. We have examined five specimens from Nagasaki, two from Tokyo, and one from Wakanoura. It is widely distributed through the warmer parts of both oceans.

A comparison of our Japanese specimens, with others from the Hawaiian Islands, Jamaica, and Brazil, reveals no specific differences.

(*μυώψ*, nearsighted).

2. SYNODUS Gronow.

Synodus Gronow, Mus. Ichth., II, 1763, no. 151 (*Synodus*).
Tirus Rafinesque, Caratteri, 1810, p. 56 (*marmoratus*).
Saurus Cuvier, Règne Animal, 1st ed., 1817, p. 169 (*saurus*).
Alpismaris Risso, Eur. Merid., III, 1826, p. 458 (*risso* = young of *saurus*).
Laurida Swainson, Class. Animal., II, 1839, p. 287 (*mediterranea* = *saurus*).

Body elongate, subterete; head depressed; snout triangular, rather pointed; interorbital region transversely concave; mouth very wide; first superior pharyngeal cartilaginous, second toothless, third and fourth separate, with teeth; lower pharyngeals separate; premaxillaries not protractile, very long and strong, more than half length of head; maxillaries closely connected with premaxillaries and very small or obsolete; premaxillaries with one or two series of large, compressed, knife-shaped teeth, the inner and larger depressible; palatine teeth similar, smaller, in a single broad band; lower jaw with a band of rather large teeth, the inner and larger ones depressible; a patch of strong, depressible teeth on tongue in front, a long row along the hyoid bone; jaws subequal; eye rather large, anterior; supraorbital forming a projection above the eye; pseudobranchiæ well developed; gill-rakers very small, spine-like; gill-membranes slightly connected; top of head naked, cheeks and opercles scaled like body; body covered with small, adherent, cycloid scales; no luminous spots; dorsal fin short, rather anterior; pectorals moderate, inserted high; ventrals anterior, not far behind pectorals, large, the inner rays longer than the outer; anal short; caudal narrow, forked; vent posterior, much nearer base of caudal than base of ventrals; branchiostegals 12 to 16; stomach with a long, blind sac and many pyloric cæca; skeleton rather firm.

Species numerous; voracious fishes of moderate size, inhabiting sandy bottoms of most shallow, warm seas.

(*σύν*, together; *ὀδούς*, tooth.)

2. SYNODUS JAPONICUS (Houttuyn).

Cobitis japonica[a] Houttuyn, Verh. Holl. Maat. Harlem, XX, 1782, p. 450 (Nagasaki).

[a] Houttuyn's description of *Cobitis japonica* is very incomplete. It must, however, refer to some species of lizard-fish from Nagasaki. In the number of fin rays the description agrees with the present species, and not with any other. The following is a translation of Houttuyn's account: Head beardless, rather short; mouth with both jaws full of sharp teeth; body terete and fleshy like that of a snake or eel. D. 12; A. 9; P. 12; V. 8. Length, 5 inches. None of the other Japanese species except *Synodus varius* shows such a difference between dorsal and anal.

HIRAKUTSU[a]-ESO (SNAKE-ESO); HIRAKUCHI ESO (WIDE-MOUTH ESO); TORAESO (TIGER ESO); AKAESO (RED ESO); ISE ESO (ESO OF ISE).

Salmo varius LACÉPÈDE, Hist. Nat. Poiss., V, 1803, p. 224, pl. III, fig. 3 (Ile de France).

Saurus varius GÜNTHER, Cat. Fish., V, 1864, p. 395 (in part).—ISHIKAWA, Prel. Cat., 1897, p. 22 (Nagasaki, Riu Kiu Islands).

Synodus varius STEINDACHNER, Denks. Ak. Wiss. Wien, LXX, 1900, p. 513 (Honolulu, Laysan).—JORDAN and SNYDER, Check List, 1901, p. 56.—JORDAN and EVERMANN, Bull. U. S. Fish Comm., XXIII for 1903 (July 29, 1905), Pt. 1, p. 63, pl. II, fig. 14 (Hilo, Honolulu).

Saurus variegatus QUOY and GAIMARD, Voy. Uranie, Poiss., 1824, p. 223, pl. XLVIII, fig. 3 (Maui).

Synodus variegatus SEALE, Occas. Papers Bishop Mus., I, Pt. 4, 1901, p. 63 (Guam).

Synodus synodus BLEEKER, Atlas Syn., p. 154, pl. II, fig. 5 (Java, etc.) (not *Esox synodus* Linnæus).

Saurus lucius TEMMINCK and SCHLEGEL, Fauna Japonica, Poiss., 1847, p. 232, pl. CVI, fig. 1 (Shimabara, near Nagasaki).

Synodus sharpi FOWLER, Proc. Ac. Nat. Sci., Phila., 1900, p. 497, pl. XIX, fig. 2 (Hawaiian Islands).

Habitat.—Western Pacific Ocean and coasts of Asia and India.

Head 3.5 in length; depth 6; width of head 1.67 in its length; depth of head 1.8 in its length; snout 4.75 in head; maxillary 1.6; interorbital space 7; eye 1.5 in snout; pectoral 2.75 in head; ventral about $1\frac{1}{3}$; base of anal 3.5; D. 13; A. 8; P. 13; scales, 5–65–11.

Body elongate, rounded, the back and ventral surface depressed; head large, elongate, depressed, pointed; eye forward, high, the upper margin elevated above profile; mouth very large, oblique; maxillary long, its greatest width anterior to the middle of its length; the mandible very large and powerful; jaws subequal when mouth is closed, the mandible slightly inferior; teeth in jaws in two irregular series, depressible, those in upper jaw more or less visible when mouth is closed; teeth on vomer and palatines depressible, in a narrow band on each side of latter; tongue and basi-branchials with a band of depressible teeth, forming a triangular patch of large ones on the vomer; tongue sharply pointed, free in front; nostrils very close together, the anterior one with a small fleshy flap; interorbital space concave; top of head roughened; gill opening large, the narrow membrane free from isthmus; gill-rakers forming tooth-like asperities on inner surface of branchial arches; gill filaments short, rather coarse, blunt; pseudobranchiæ small, few in number; peritoneum silvery.

Scales large, cycloid; 6 rows on cheek; a series of enlarged scales along margin of preopercle; occiput and sides of head scaly, the rest naked; a broad scaly flap between ventrals and a pointed scale at their outer axil; lateral line nearly straight to base of caudal.

Origin of dorsal midway between tip of snout and origin of adipose dorsal; last dorsal ray a trifle more than half the length of longest

[a] Hirakutsu, "broad-shoe," is the name of a venomous serpent.

ray of fin; origin of adipose dorsal about halfway between tip of last dorsal ray and base of caudal; anal small, its origin before adipose fin; caudal deeply emarginate with pointed lobes; pectoral small, not reaching to dorsal; ventrals large, reaching about to end of base of dorsal.

Color in alcohol, dusky above, sides and belly yellowish, sides of back with about eight or nine dusky cross bars or pairs of bars, these often taking the form of quadrate spots with paler center; an oblique black spot on upper part of opercle; jaws barred; fins, except the pectoral, faintly barred. In life, in Japan as in Honolulu, some specimens have brick-red markings while others from shallower water are olive green. The first are called Akaeso (aka meaning red), the others Ise eso, from the province of Ise. This fish is common throughout the western Pacific from Hawaii to the coasts of Japan. We have 6 specimens from Wakanoura and 3 from Nagasaki. This species is closely allied to the rare Atlantic species, *Synodus synodus* (Linnæus), with which Doctor Bleeker unites it. Specimens of the Atlantic species examined from Bahia have, however, larger scales (58 instead of 65.) If the Pacific Coast species is really distinct, it must apparently stand as *Synodus japonicus*.

3. SAURIDA Cuvier and Valenciennes.

Saurida Cuvier and Valenciennes, Hist. Nat. Poiss., XXII, 1849, p. 499 (*tumbil*).

Body elongate, subcylindrical; tail tapering; head oblong, depressed; snout pointed, rather short; eye moderate; mouth cleft oblique, very large; premaxillary very long, styliform, tapering; maxillary thin, long, closely adherent to premaxillary; teeth cardiform, those of inner series longest, slender, depressible both downward and inward, present on jaws, tongue, and palatines, on the latter forming a double band on each side, the inner band shorter than the other; gill-opening very wide, gill membranes not attached to isthmus; branchiostegals numerous; dorsal fin nearly in the middle of length of body, with 13 or fewer rays; adipose fin small; anal short; caudal forked; pectoral short or of moderate length; ventral 9-rayed, the inner rays not much longer than the outer ones, inserted before dorsal, not far from the pectoral.

Fishes of the tropical seas of the western Pacific; species not very numerous.

(*σαῦρος*, lizard; *εἶδος*, resemblance.)

KEY TO SPECIES.

a. Adipose eyelid narrow; scales 54; color nearly plain.....*argyrophanes*, 3.
aa. Adipose eyelid broad; scales 63; color nearly plain.....*eso*, 4.

3. SAURIDA ARGYROPHANES (Richardson).

ESO, MAESO (TRUE ESO) NIREDOESO.

Saurus argyrophanes Richardson, Ichth. China, 1846, p. 302 (Canton) (described from a drawing).

Saurida argyrophanes Günther, Cat. Fish., V, 1864, p. 400 (Chinese and Japanese seas).—Namiye, Class. Cat., 1881, p. 106 (Tokyo).—Ishikawa, Prel. Cat., 1897, p. 22 (Tokyo).—Jordan and Evermann, Proc. U. S. Nat. Mus., XXV, 1902, p. 329 (Formosa).—Jordan and Snyder, Proc. U. S. Nat. Mus., XXIII, 1900, p. 350 (Tokyo); Check List, p. 56, 1901 (Yokohama).

Aulopus elongatus Temminck and Schlegel, Fauna Japonica, Poiss., p. 233, 1847, pl. cv, fig. 2, (Nagasaki).

Habitat.—Coast of Japan and China, southward to the Philippines.

Head 4⅓ to 4¼ in length without caudal; depth varying with age from 7 in very large specimens to 9 in the young; greatest width of head 2 in its length; maxillary 1½ in head; interorbital space equal to snout, 4 in head; D. 11; A. 10; P. 14; V. 9; scales 4–54–6.

Body elongate, subcylindrical, back but little elevated, anteriorly broad and flattened; head long, depressed, broad; snout broad, blunt, with a broad shallow depression on top of snout running back of eyes; a bony protuberance at anterior end of groove, back of tip of snout; eyes well forward, high, 6 in head; adipose eyelid narrow, not extending to pupil; anterior nostril concealed by a thin, fleshy flap.

Mouth large, oblique, the jaws equal; lips narrow, so that teeth are visible; teeth in several rows, those of inner row much the largest; palatines armed with rows or bands of small or fine teeth, those of inner rows much larger than the rest; tongue small, free anteriorly, covered with bands of fine teeth; branchial arches with bands of fine teeth, those in throat largest; all teeth depressible inward. Gill openings very large, the gill membranes free from isthmus; gill filaments moderately long, rather coarse and blunt; pseudobranchiæ numerous, well developed. Lateral line straight, keeled, strongly so posteriorly.

Scales large, cycloid, rather deciduous, three rows on cheeks; opercles and occiput scaled, rest of head naked; caudal scaled nearly its whole length; a very long, narrow, pointed scale at upper axil of pectoral; a similar one at ventral is more than twice as long as the broad pointed scale at inner angle of ventral and eventually reaches more than half the length of the ventral fin. Dorsal and anal each with a basal sheath of long, narrow, pointed scales.

Dorsal short, high, its longest spine 1⅓ in head, decreasing in height very rapidly, the last spine less than ¼ as long as second (in one large specimen the second spine is 1⅕ times longer than head); the distance from tip of snout to origin of dorsal equals distance from origin of dorsal to posterior margin of depressed adipose dorsal;

the latter fin very small; pectoral comparatively long, reaching to a point above origin of ventral, or beyond; ventral reaching less than halfway to vent; anal fin small, the distance from its origin to base of caudal about equal to length of head; caudal deeply forked.

Color in alcohol, dull brown above lateral line, becoming silvery yellow below. Pectorals, dorsals, and caudal tipped with blackish; ventrals and anal uniform yellowish.

Of this species we have examined 7 specimens from Wakanoura, 6 from Nagasaki, 3 from Kobe, 2 from Tokyo, and 1 from Kawatana. It was seen also at Hakata and at Hiroshima. It is generally common in southern Japan, and is a common food fish in the markets. *Aulopus elongatus* Schlegel seems to be this species, the figure showing no adipose eyelid, but the number of scales is too large. *Saurus argyrophanes* we place here, as Günther counts 54 scales and Richardson does not speak of the adipose eyelid.

(*ἀργύροεις*, silvery; *φαίνω*, to show.)

4. SAURIDA ESO Jordan and Herre, new species.

ESO, OESO (LARGE ESO).

Saurus badi Cantor, Catalogue of Malayan Fishes, 1850, p. 270 (Sea of Pinang, Malayan Peninsula, Singapore); (not *Saurus badi* Cuvier, an Indian species, with the ventrals blackish, the scales 55, and the adipose eyelid large.)

Saurida japonica Jordan and Evermann, Proc. U. S. Nat. Mus., XXV, 1902, p. 329 (*comparison with S. argyrophanes*) (not *Cobitis japonicus* of Houttuyn).

Habitat.—South coasts of Japan, south to Malaysia.

Head $4\frac{5}{6}$ in length without caudal; depth $7\frac{3}{8}$; greatest width of head $1\frac{5}{7}$ in its length; maxillary $1\frac{1}{2}$ in head; interorbital space equals

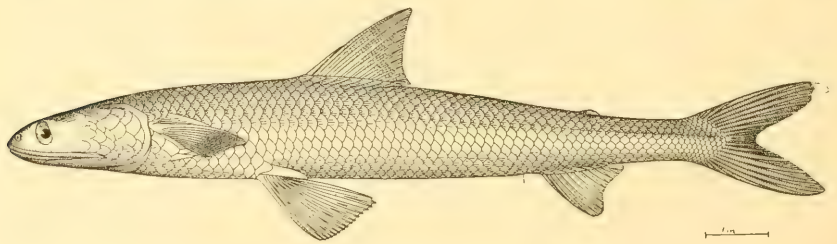


Fig. 1.—Saurida eso.

distance from tip of snout to middle of pupil, a trifle more than 3 in head; snout $3\frac{1}{2}$ in head; D. 11; A. 10; P. 14; V. 9; scales 5–63–7.

Body elongate, subcylindrical, becoming somewhat compressed and laterally keeled on posterior portion; head depressed, broad; snout broad, flat, rather blunt; eye placed well forward, $5\frac{1}{2}$ in head; adipose eyelid well developed, broad, extending to or partly covering pupil; much larger than in *Saurida argyrophanes*. Anterior nostril with a well-developed fleshy flap or tube. Top of head with numerous dendritic muciferous tubules.

Mouth large, slightly oblique, the mandible slightly inferior; teeth in several rows, those of inner row largest, exposed by the narrow, thin lip; pterygoids, palatines, tongue, and gill arches with bands of fine teeth, those of inner row usually largest; all teeth depressible inward; no teeth on vomer. Gill openings very large, membranes free from isthmus; gill filaments moderately coarse, blunt; pseudobranchiæ numerous, large. Lateral line straight, prominent, and strongly keeled posteriorly.

Scales of medium size, cycloid; four rows on cheeks, opercles scaled; one or two scales at center of posterior margin of occiput; remainder of head naked. Caudal fin scaled; a long, pointed and very thin scale at axil of pectoral; a long, broad, rounded scale at outer angle of ventral, less than half the length of fin; at inner angle of fin a large pointed scale, nearly as long as the outer one; dorsal and anal fins each with a basal sheath of elongated, pointed scales.

Dorsal fin short, high, the second spine about $1\frac{1}{4}$ in head, the last spine about $\frac{1}{5}$ as long as second; distance from tip of snout to origin of first dorsal equals distance from the latter to posterior margin of base of adipose dorsal; pectoral medium, falling considerably short of a point above origin of ventral, $1\frac{5}{7}$ in head; adipose dorsal very small, inserted above middle of anal; ventrals inserted forward of first dorsal and extending a trifle beyond its posterior margin; anal short, its length little more than $\frac{1}{3}$ of head; distance from its origin to base of caudal approximately equals length of head; caudal medium, deeply forked.

Color in alcohol, dusky brown above lateral line, some scales with paler centers; below, more or less abruptly, silvery yellow; pectorals dorsals, and caudal tipped with blackish; ventrals and anal uniform yellowish.

Here described from the type, Cat. No. 57847, U. S. Nat. Mus., $13\frac{1}{4}$ inches long, from Wakanoura. We have also examined two cotypes from Kobe and one from Tsuruga, Nos. 20161 and 20162, Stanford University.

This is the largest species in the group. It differs from *Saurida argyrophanes* in the comparative proportions of the pectoral fin, and of the outer axillary ventral scale, in the greater breath of the head, and especially in the greater number of scales in the lateral line, the larger adipose eyelid, and in the absence of the marked occipital depression.

Saurida tumbil Cuvier has been recorded from Japan by Bleeker, but doubtless *S. eso* has been mistaken for it. *Saurida tumbil* of the East Indies has the adipose eyelid small, the scales 60, and the back barred with blackish.

(*Eso*, Japanese name of the species of *Synodus* and *Saurida*.)

4. HARPODON Le Sueur.

Harpodon Le Sueur, Journ. Ac. Nat. Sci. Phila., V, 1825, p. 50 (*microps*=*nehereus*) (misprinted *Harpadon*).

Triurus Swainson, Class. Anim., 1839, II, p. 288 (*microcephalus*=*nehereus*).

Sauridichthys Bleeker, Pisces Java, Nat. Tyd. Ind., XV, 1856, p. 163 (*ophiodon*=*nehereus*).

Body elongate, compressed; snout short; bones of head soft and partly modified into wide muciferous channels; eyes small. Cleft of mouth deep; margin of upper jaw formed by the premaxillaries, which are thin and tapering; no maxillaries. Teeth cardiform, recurved, unequal in size, depressible, the largest on the jaws and more or less barbed. Teeth on premaxillaries, mandible, palatines, tongue, and hyoid. Branchiostegals from 23 to 25; gill openings wide; gill membranes free from isthmus.

Dorsal short, near middle of body length; adipose fin small; pectorals and ventrals long; caudal three lobed.

Scales thin, deciduous, none on the anterior portion of the body, no luminous spots. No air bladder; pyloric appendages 16.

Dorsal fin short, of soft rays only; pectorals and ventrals present; anal moderate or long; caudal forked.

Skeleton rather well ossified; air bladder small or wanting; intestinal canal short; no eggs inclosed in the sacs of the ovary and extended through an oviduct.

Species few, Asiatic, one of them being the well-known "Bombay Duck," or Bummaloh, *Harpodon nehereus*, used when dried as a condiment. A shore fish of wide distribution, the Japanese species in deep water.

(ἅρπη, scythe; ὀδούς, tooth.)

5. HARPODON MICROCHIR Günther.

MIZUTENGU (WATER GOBLIN.)

Harpodon microchir Günther, Ann. and Mag. Nat. Hist., 1878, p. 487 (off Tokyo); Report on the Shore Fishes of the Challenger, 1880, p. 71 (Tokyo) (same specimens).

Habitat.—Open sea off Japan.

Head $5\frac{1}{6}$ to $5\frac{9}{11}$ in total length without caudal; depth from $7\frac{1}{2}$ to $8\frac{1}{2}$; interorbital space 4 in head; intermaxillary $1\frac{1}{4}$; eye small, about 9 in head. D. 14; A. 14; P. 11; V. 9.

Lateral line 58 to 60, extending to extremity of central caudal lobe. Body slender, elongate, subcylindrical, the posterior portion somewhat laterally compressed; head broad above, with prominent bony ridges; a bony tubercle just behind the very short broad snout; opercular flap prolonged, large, thin, membranaceous; eye well forward, high, with a narrow adipose lid encircling the orbital space;

nostrils close together, the anterior one small, covered by a fleshy flap; posterior nostril large, open; 2 or 3 minute pores between anterior nostril and tip of snout; top of head with 2 lateral and 1 median broad muciferous channel; mouth very large; the lower jaw strongly projecting; lips narrow, exposing the teeth; these arranged in two or three rows, recurved, depressible inward, straight, arrow-shaped or with a single barb at posterior margin of the point; teeth of inner row largest. Bands of unequal, recurved, inwardly depressible teeth also on tongue, inner side of gill arches, and palatines, the last having two bands. Gill openings very large, membranes free from isthmus; gill filaments rather short, moderately coarse; pseudobranchiæ small, few in number. Lateral line straight, formed of elongate, thin, pointed scales; a pore above and below each scale.

Scales small, cycloid, on posterior portion of body, extending forward to ventrals on belly, but above the lateral line ceasing at posterior end of depressed dorsal. Basal portion of adipose dorsal

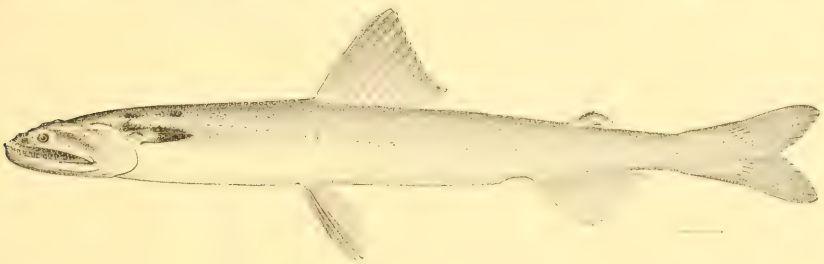


Fig. 2.—Harpodon microchir.

scaled. Remainder of body naked except for a row of minute scales on either side of lateral line.

Dorsal fin short, moderately high; the third spine highest, from 6½ to 7 in total length; distance from tip of snout to origin of first dorsal equal to, or slightly greater than, distance from the latter point to posterior margin of depressed adipose dorsal; pectoral small, its length about 2½ in head; adipose dorsal small, inserted over middle of anal; ventrals inserted just forward of first dorsal and extending posteriorly beyond insertion of dorsal; anal moderate, its length variable, in some specimens longer and in others shorter than dorsal; caudal medium, of three pointed lobes, the central one much the smallest.

Color, translucent brownish, in spirits, dusky above, becoming brownish or yellowish laterally; throat, belly, and lower part of head silvery gray with a pinkish suffusion. Pectorals black; ventrals and anal whitish or yellow; dorsal and caudal dusky or blackish.

We have examined twelve specimens of this singular and rare fish, ranging in length from 11½ inches to 16 inches. They were taken in

deep water off the headland of Awa at the entrance to the Bay of Tokyo.

The species was previously known from a single specimen 27 inches long obtained by the *Challenger* expedition at Tokyo. The species is regarded as a food fish, although very rare. It differs from *Harpodon nehereus* in the small pectorals.

(*μικρός*, small; *χείρ* hand.)

SUMMARY.

Family SYNODONTIDÆ.

1. *Trachinocephalus* Gill, 1861.

1. *myops* Forster, 1801; Tokyo, Wakanoura, Nagasaki.

2. *Synodus* Gronow, 1763.

2. *japonicus* (Houttuyn), 1782; Wakanoura, Nagasaki.

3. *Saurida* Cuvier and Valenciennes, 1849.

3. *argyrophanes* (Richardson) 1846; Tokyo, Kobe, Hiroshima, Wakanoura, Kawatana, Hakata, Nagasaki.

4. *eso* Jordan and Herre, 1907; Wakanoura, Kobe, Tsuruga.

4. *Harpodon* Le Sueur, 1825

5. *microchir* Günther, 1878, Tokyo.

NEW AND CHARACTERISTIC SPECIES OF FOSSIL MOLLUSKS FROM THE OIL-BEARING TERTIARY FORMATIONS OF SOUTHERN CALIFORNIA.

By Ralph Arnold,
Paleontologist, U. S. Geological Survey.

INTRODUCTION.

Among the fossils commonly found in or characteristic of certain of the oil-bearing Tertiary formations of southern California are the species and varieties mentioned in the following pages. The new forms are described and figured; those previously described are simply figured, but a brief note concerning their occurrence is inserted in the explanation accompanying each drawing. It has been deemed advisable to insert figures of the old species in this paper because the descriptions and illustrations of these forms are in publications inaccessible to most readers, and it is essential for the proper identification of the faunas that certain of the old species be known. The differentiation of the various geologic formations in the southern coast ranges of California depends almost entirely upon their palentology, so that it has been the aim of the writer to give in this paper those species and only those which will aid in the determination of the horizon of the various faunas found in that region. These fossils, together with some others, will be figured on Plates XXV to XLI, Bulletin No. 309, U. S. Geological Survey.

The following new species and varieties are found in the yellow sandstone of the lower Miocene at the head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California.

LIST OF LOWER MIOCENE FOSSILS FROM TOPANGA CANYON.

Mytilus mathewsonii Gabb var. *expansus*, new variety.
Cerithium topangensis, new species.
Chlorostoma dalli, new species.
Bathytoma keepi, new species.
Macron merriami, new species.
Ocinebra topangensis, new species.
Purpura edmondi, new species.
Sigaretus perrini, new species.
Turbo topangensis, new species.

Associated with them at this locality are:

Callista (*Amiantis*) *diabloensis* Anderson.
Cardium, species (sharp ribs).
Cardium, species (square ribs).
Chione temblorensis Anderson.
Dosinia ponderosa Gray.
Glycymeris, species (large).
Macoma cf. *nasuta* Conrad.
Ostrea titan Conrad.
Pecten bowersi Arnold.
Pecten cf. *miguelensis* Arnold.
Phacoides richthofeni Gabb.
Venus pertenuis Gabb.
Agasoma cf. *kernianum* Cooper.
Bittium, species.
Calliostoma, species.
Cancellaria cf. *condoni* Anderson.
Cylichna, species.
Drillia, species.
Fusus, species.
Neverita callosa Conrad.
Trochita costellata Conrad.
Trochita cf. *inornata* Gabb.
Trophon, species.
Turritella ocoyana Conrad.
Turritella variata Conrad.

The following new species and varieties are from the sandstone in the Pliocene (middle part of the Fernando formation) near the Pacific Coast Oil Company's wells in Elsmere Canyon, 2½ miles southeast of Newhall, Los Angeles County, California.

LIST OF LOWER PLIOCENE FOSSILS FROM ELSMERE CANYON.

Cancellaria fernandoensis, new species.
Cardium quadrigenarium Conrad var. *fernandoensis*, new variety.
Cypraea fernandoensis, new species.
Murex eldridgei, new species.
Pisania fortis Carpenter var. *angulata*, new variety.
Priene oregonensis Redfield var. *angelensis*, new variety.
Turritella cooperi Carpenter var. *fernand ensis*, new variety.

Associated with these are:

Amiantis callosa Conrad.
Arca trilineata Conrad.
Bathytoma cf. *carpenteriana* Gabb.
Callista subdiaphana Carpenter.
Chione, new species (small).
Chrysodomus arnoldi Rivers?
Cryptomya californica Conrad.
Macoma indentata Carpenter.
Macoma, species.
Mactra cf. *hemphilli* Dall.
Modiolus rectus Conrad.

Monio macroschisma Deshayes.
Mya truncata Linnæus.
Neptunea humerosa Gabb.
Neverita recluziana Petit.
Olivella intorta Carpenter.
Panopea generosa Gould.
Pecten cf. *caurinus* Gould.
Pecten estrellanus Conrad var. *catalinæ* Arnold.
Pecten healeyi Arnold.
Pecten cf. *parmelee* Dall.
Phacoides annulatus Reeve.
Tapes tenerrima Carpenter.
Tellina idæ Dall.
Tritonium, species.
Trochita filosa Gabb.

Associated with the new forms *Nassa hamlini* and *Prienè oregonensis* Redfield var. *angelensis* in the bluish-gray clayey shale of the lower Pliocene (middle Fernando formation) in the Third Street tunnel, Los Angeles, are the following:

LIST OF LOWER PLIOCENE FOSSILS FROM THIRD STREET TUNNEL.

Arca multicostata Sowerby.
Astarte, species.
Carditoid.
Lima hamlini Dall.
Macoma, species undetermined.
Ostrea veatchii Gabb.
Pecten ashleyi Arnold.
Pecten latiauritus Conrad.
Pecten opuntia Dall.
Pecten pedroanus Trask (abundant).
Pecten stearnsii Dall.
Buccinum, species undetermined.
Fissuridea murina Carpenter.
Neverita recluziana Petit.
Pleurotoma, species undertermined, coral, bird bones.

The brachiopod, *Terebratalia occidentalis* Dall is associated with the following fauna, the equivalent of that of the San Diego formation, in the coarse sandstone and gravel immediately above the unconformity between the lower Pliocene (middle Fernando formation) and the Miocene shale near the mouth of Temescal Canyon, one-half mile north of Port Angeles, Los Angeles County:

LIST OF LOWER PLIOCENE FOSSILS FROM TEMESCAL CANYON.

Terebratalia smithi Arnold.
Pecten ashleyi Arnold.
Pecten hastatus Sowerby.
Pecten healeyi Arnold (abundant).
Pecten stearnsii Dall.
Opalia varicostata Stearns.

NEW MIOCENE SPECIES AND VARIETIES.

OSTREA ELDRIDGEI, new species.

Plate XLII, figs. 2 and 2*a*.

Description.—Shell about 150 mm. in length, inequivalve, the left very convex, the right flat or slightly concave. Left valve with incurved umbo; a prominent, falcate, evenly convex ridge extends from near the umbo to the margin of the left valve posteriorly; surface of this valve and ridge foliaceous and more or less inclined to be fluted. Left valve approximately flat, with foliaceous surface.

Dimensions.—Longitude, 147 mm.; latitude, 87 mm.; diameter (distance through both valves), 82 mm.

Notes.—This species is distinguished from the other Tertiary oysters of the California Tertiary by the prominent posterior ridge and incurved umbo of the left valve. The species has the external appearance of a *Gryphæa*. Named in honor of the late Mr. George Homans Eldridge, of the U. S. Geological Survey. The type was associated with *Turritella ineziana* Conrad at the Grimes Canyon locality.

Type.—Cat. No. 164966, U.S.N.M.

Locality.—Elkins ranch, east of Grimes Canyon, near Fillmore, Ventura County, California. (G. H. Eldridge.)

Horizon.—Lower Miocene, supposed equivalent of the Vaqueros formation.

MYTILUS MATHEWSONII Gabb var. EXPANSUS, new variety.

Plate XLIII, fig. 2.

Description.—Shell wedge-shaped, rounded behind, curved; posterior margin curved, semiangular in middle, anterior margin more nearly straight; beaks terminal, blunt; surface sculptured by irregular concentric lines and ridges of growth and by fine radiating striæ.

Dimensions.—Longitude, 105 mm.; latitude, 50 mm.; diameter of both valves, 60 mm.

Notes.—This variety differs from the typical form in being somewhat smaller, relatively broader, and with straighter anterior margins. The fine radial striation is also said to be lacking in the typical form. It is associated at the type locality with *Scutella fairbanksi* Merriam, *Ostrea* near *titan* Conrad, and *Pecten sespeensis* var. *hydei* Arnold.

Type.—Cat. No. 164968, U.S.N.M.

Locality.—Near Torrey Canyon oil wells, southwest of Piru, Ventura County, California. (G. H. Eldridge.)

Horizon.—Lower Miocene, supposed equivalent of the Vaqueros formation.

PLEUROTOMA (BATHYTOMA) KEEPI, new species.

Plate XLVI, fig. 5.

Description.—Shell large for the genus *Pleurotoma*, fusiform; spire about as long as aperture; whorls six, angulated below the middle, sloping concavely above and about the same below. Surface ornamented by a rim of nodes (ten on the body whorl in the type) on the angle of the whorl and by numerous revolving raised lines or ribs. Aperture narrow, narrowing rapidly from top toward bottom; inner lip straight, outer lip reflecting angulation of whorls.

Dimensions.—Longitude (restored), 60 mm.; latitude, 30 mm.

Notes.—This species is closely allied to and is doubtless the precursor of *P. tryoniana* Gabb. It was first thought that the Miocene forms were the same species as the living, but a careful comparison of specimens shows *P. keepi* to be much more abbreviated and with a relatively more angulated body whorl than *P. tryoniana*. The nodes also are somewhat sharper and are more prominently developed on the body whorl in the former. Named in honor of Prof. Josiah Keep, of Mills College, California.

Type.—Cat. No. 164993, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

MACRON MERRIAMI, new species.

Plate XLI, figs. 4 and 4*a*.

Description.—Shell small, ovate, solid; spire elevated; apex acute; whorls five, evenly convex, nearly smooth, except for a prominent furrow which passes around the body whorl one-third the way up from its base; between this prominent furrow and the umbilicus are three other less prominent grooves. Suture narrow but canal-like; aperture narrow and elliptical. Columella slightly callous posteriorly; anterior portion produced and flexed; posterior part of lip bent. Canal a mere notch. Umbilicus subperforate.

Dimensions.—Longitude, 23 mm.; latitude, 13 mm.; body whorl, 19 mm.; aperture, 16 mm.; deflection, about 70°.

Notes. This characteristic little species is closely allied to and probably is the precursor of *M. kellettii* A. Adams. It differs from the latter, however, in being relatively narrower, having a narrower shoulder at the suture and in having one more groove in the basal portion of the body whorl. Named in honor of Prof. John C. Merriam, of the University of California, Berkeley.

Type.—Cat. No. 164982, U.S.N.M.

Locality.—Head of Topanga Canyon 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

OCINEBRA TOPANGENSIS, new species.

Plate XLIII, fig. 4.

Description.—Shell large for one of this genus, fusiform; spire elevated, subacute; whorls five, strongly angulated above, giving a tabulate appearance to upper portion; whorls crossed by six or seven frills, some of which flex forward and rise to prominent points on the angle; anterior portion of whorls ornamented by about 12 rough, raised spiral lines, the alternate ones being relatively more prominent than those adjacent; posterior portion with six or seven similar lines; suture deeply appressed, undulating, distinct. Aperture subelliptical; inner lip slightly enameled; columella twisted, squamose, only slightly widened; umbilicus subperforate; canal of medium length, narrow.

Dimensions.—Altitude, 59 mm.; latitude, 30 mm.; body whorl, 46 mm.; aperture, 39 mm.

Notes.—The largest member of this genus known from the West Coast. Somewhat similar to *O. keepi* Arnold but much larger, with less prominently developed frills and much finer spiral sculpture. Named for the type locality, Topanga Canyon.

Type.—Cat. No. 164995, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

PUPURA EDMONDI, new species.

Plate XL, figs. 3 and 3*a*.

Description.—Shell fusiform, moderately thick; spire elevated; apex subacute; whorls four or five, angulated, the body whorl particularly so; nine or ten prominent nodes on the angle, each node gradually fading out above and below the angle; spiral sculpture consists of more or less obsolete ridges, of which there are about fourteen on the body whorl below the angle and three or four above it; suture appressed, distinct, somewhat wavy, the surface of the shell being corrugated near it. Aperture pyriform; outer lip slightly effuse, denticulated with seven or eight quite sharp and prominent teeth. Inner lip smooth. Umbilicus subperforate. Canal short, curved backward.

Dimensions.—Longitude, 19 mm.; latitude, 12.5 mm.; body whorl, 16.5 mm.; aperture, including canal, 14 mm.

Notes.—Unlike any other *Purpura* on the coast. Resembles *Cuma bipliciata* Gabb, but with angle higher up on whorl; umbilical region also more simple than in latter species. Named in honor of Prof. Geo. W. Edmond, of Santa Monica, California, who first discovered this species.

Type.—Cat. No. 164983, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

CERITHIUM TOPANGENSIS, new species.

Plate XL, figs. 7 and 8.

Description.—Shell turreted; apex acute; whorls nine or ten, slightly convex, with a faint suggestion of a shoulder at the posterior margin. Whorls ornamented by a varying number of spiral and longitudinal ridges of which there are eight of the former and twenty-one of the latter on the penultimate whorl of the type; the relative prominence of the two sets of ridges varies somewhat, but they are normally of about equal importance. Suture impressed; distinct. Aperture subquadrate; outer lip effuse, broadly rounded below and slightly produced in a columellar beak; inner lip straight above this beak.

Dimensions.—Longitude, 23.5 mm.; latitude, 7.5 mm.; body whorl, 10.5 mm.; aperture, 7 mm.

Notes.—Quite unlike any other West Coast Cerithium, being closest, possibly, to *C. gemmata* Hinds, from which it differs by having more numerous and more delicate longitudinal ridges and very much less pronounced nodose sculpture below the suture. Named after the type locality, Topanga Canyon.

Type.—Cat. No. 164976, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

TURBO TOPANGENSIS, new species.

Plate XLI, figs. 6, 6*a*, and 6*b*.

Description.—Shell turbinated, solid; whorls somewhat convex and prominently tuberculated, one row of about nine sharp tubercles surmounting the whorl just below the suture, another band of less prominent ones in the middle of the whorl, and the base of the whorl ornamented by another spiral row, the tubercles of which are almost as prominent as the top row; in addition to this there is a secondary sculpture consisting of numerous faint ridges crossing the whorls diagonally from the base posteriorly toward the suture. Base ornamented by three prominent spiral ridges, the outer one tuberculated. Suture impressed, distinct. Aperture round, slightly produced and somewhat flaring in front.

Dimensions.—Altitude, 10.5 mm.; latitude, 18 mm.

Notes.—A unique species, somewhat resembling *Turbo squamigera* Reeve, but differing from the latter in having less tabulated and angulated whorls, a simpler sculpture of tubercles, and in having a

secondary transverse sculpture. Named after the type locality, Topanga Canyon.

Type.—Cat. No. 164980, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

TURRITELLA INEZIANA, Conrad var. SESPEENSIS, new variety.

Plate LI, fig. 6.

Description. Shell turreted, with slender, tapering spire; number of whorls variable, eight or more; whorls slightly concave, with one very prominent revolving ridge at base, and two equal but less prominent ones above. There is also evidence in the type (a rather poorly preserved specimen) of minor spiral lines or riblets, especially one at the base of the major ridge; suture deeply impressed.

Dimensions.—Of broken and slightly distorted type; longitude, 34 mm.; latitude, 10 mm.

Notes.—This form is distinguishable from the typical *T. ineziana* (*T. hoffmanni* of most West Coast authors) by its small size and much more prominently developed spiral ridges. It is abundant but poorly preserved at the type locality. May possibly be of specific value, but if so is allied to *T. ineziana*. It is associated at the type locality with *Modiolus* sp., *Ostrea* cf. *idriaensis* Gabb, and *Pecten sespeensis* Arnold. Named after the type locality, Sespe oil district, Ventura County, California.

Type.—Cat. No. 164970, U.S.N.M.

Locality.—Tar Creek, north of Fillmore, Ventura County, California. (G. H. Eldridge.)

Horizon.—Vaqueros formation (lower Miocene).

SIGARETUS PERRINI, new species.

Plate XLI, fig. 5.

Description.—Shell very much elongated for one of this genus; whorls, three or four (type decollete), slightly convex; apex subacute; whorls ornamented with numerous rough revolving lines, each alternate one being considerably more prominent than those adjacent; suture prominent, impressed; aperature pyriform, narrow posteriorly; lower portion of columellar lip slightly flaring.

Dimensions.—Altitude (restored), 21 mm.; latitude, 9.5 mm.; body whorl, 18.5 mm.; aperture, 14 mm.

Notes.—This unique species is entirely unlike anything else in the West Coast fauna, so far as known. It is certainly very much elongated for this genus. Named in honor of Prof. James Perrin Smith, of Leland Stanford Junior University, California.

Type.—Cat. No. 164979, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

CHLOROSTOMA (OMPHALIUS) DALLI, new species.

Plate XL, figs. 4, 4*a* and 4*b*.

Description.—Shell conoidal; spire somewhat elevated; apex obtuse; whorls four, slightly convex, angulated just above the suture; portion of whorl above angle crossed by (in the type twelve) transverse ridges or waves running obliquely backward from the angle and appressing against the antecedent whorls. Revolving ridge on angle, and, also on body whorl, on a second equally prominent angle, at the base of the whorl. Whole surface of shell, including base, ornamented by fine revolving lines (in the type there are four of these between the two angles on the body whorl). Five equivalent narrow revolving furrows also ornament the top of the body whorl. Suture distinct. Umbilicus deep and more or less effuse. Aperture circular; columellar lip slightly twisted around umbilicus. Outer lip unknown.

Dimensions.—Altitude, 10 mm.; latitude, 12.5 mm.

Notes.—This species differs from *Chlorostoma aureotinctum* Forbes, to which it is allied, by the lack of the prominent furrows in the base and the presence of the revolving furrows in the top of the whorl. *C. dalli* is a variable form, no two specimens being exactly similar. It grades into the two varieties next described. Named in honor of Dr. William Healy Dall, of the United States Geological Survey.

Type.—Cat. No. 164984, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

CHLOROSTOMA (OMPHALIUS) DALLI var. INORNATUS, new variety.

Plate XL, fig. 5.

Description.—Similar to *C. dalli* except that the transverse waves are obsolete and the revolving furrows on top of the whorls are more numerous and less prominent.

Dimensions.—Altitude, 10 mm.; latitude, 15 mm.

Notes.—The type of this variety is flatter than the typical form, but this is due to crushing.

Type.—Cat. No. 164986, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California. (G. W. Edmond and Ralph Arnold.)

Horizon.—Lower Miocene.

CHLOROSTOMA (OMPHALIUS) DALLI var. SUBNODOSUS, new variety.

Plate XL, figs. 6 and 6*a*.

Description.—Similar to *C. dalli* except that the transverse waves are less pronounced and the spiral sculpture is somewhat coarser. A more or less prominent ridge revolves about the umbilicus.

Dimensions.—Altitude, 10 mm.; latitude, 13.5 mm.

Type.—Cat. No. 164985, U.S.N.M.

Locality.—Head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County, California.

Horizon.—Lower Miocene.

PLIOCENE SPECIES AND VARIETIES.

TEREBRATALIA OCCIDENTALIS Dall.

Plate XLIX, figs. 6, 7, 7*a*, 8, 8*a*, 9, and 9*a*.

Terebratalia occidentalis DALL, Proc. Cal. Acad. Sci., IV, 1871, p. 182, pl. I, fig. 7.

Description.—Shell from subcircular to subelliptical in outline, rather thin; pedicle (lower) valve with mesial flexure concave; on each side of this are usually two prominent ridges, and beyond these still a second pair; surface of valve sometimes nearly smooth, but more often with radiating ridges of varying prominence; lines of growth usually discernible, some being quite prominent; brachial (upper) valve strongly medially convex, with one and sometimes two ridges on either side; secondary sculpture similar to that of lower valve. Beak with a concave or flattened area on each side of the deltidium. Shell broader proportionately in the younger stages of growth.

Dimensions.—Longitude, 27 mm.; latitude, 29 mm.

Notes.—This variable species passes through the same mutations as *T. transversa* Sowerby, from which it differs by having the mesial flexure of the pedicle valve concave and of the brachial valve convex instead of vice versa as in *T. transversa*. Very abundant at Temescal Canyon locality; also found recent on the Pacific coast of North America.

Figured specimens.—Cat. No. 164996, U.S.N.M.

Locality.—Near the mouth of Temescal Canyon, 3 miles north of Santa Monica, Los Angeles County, California. (Ralph Arnold and J. J. Rivers).

Horizon.—Recent and lower Pliocene, probably equivalent of middle Fernando formation.

CARDIUM QUADRIGENARIUM Conrad var. FERNANDOENSIS, new variety.

Plate XLVIII, figs. 2 and 2*a*.

Description.—Shell smaller than the typical form, oval, ventricose; umbones central, prominent, turned only slightly anteriorily; surface sculptured with about thirty-six prominent, subangular radiating ridges roughened over the anterior and posterior portions of the shell by prominent pointed tubercles on the posterior angle; those ridges near the posterior margin are less prominent, but are nodose for nearly their whole length.

Dimensions.—Altitude, 55 mm.; longitude, 58 mm.; diameter (both valves), 38 mm.

Notes.—This variety is more oblique, has narrower umbones, is relatively less in diameter, and has fewer and less prominently spinose ribs than the typical form. The typical form has over forty ribs, while var. *fernandoensis* has but thirty-six. Named after the Fernando formation of which it is supposed to be characteristic.

Type.—Cat. No. 164947, U.S.N.M.

Locality.—Elsmere Canyon, near Pacific Coast Oil Company's well, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (lower Pliocene).

CANCELLARIA FERNANDOENSIS, new species.

Plate L, fig. 4.

Description.—Shell about 20 to 24 mm. in altitude; broadly fusiform; spire elevated; whorls four or five, sharply angulated at about two-thirds height of whorl; flat or slightly convex both above and below the angle; whorls crossed by numerous (18 on body whorl) broad longitudinal varices which extend from suture to suture, being fainter above than below; surface also ornamented by equal equidistant raised spiral lines, about three or four below the angle, two or three above. Suture appressed, distinct. Lower portion of type broken.

Dimensions.—Altitude (restored), about 20 mm.; latitude, 13 mm.

Notes.—This species is closely allied to the tropical species *C. candida* Sowerby, but is distinguishable by its broader form, much broader varices, and more evenly spaced spiral lines. Named for the Fernando formation, of which it is supposed to be characteristic.

Type.—Cat. No. 164956, U.S.N.M.

Locality.—Elsmere Canyon, near Pacific Coast Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (lower Pliocene).

PISANIA FORTIS Carpenter var. ANGULATA, new variety.

Plate L, figs. 6 and 7.

Description.—Shell fusiform, short; spire elevated; apex subacute to subangular, whorls angular, about three-fourths of the whorl being below the angle; body whorl below the angle quite uniformly convex. The surface sculpture varies considerably in individual specimens; in the type the sculpture of the body whorl consists of ten equal subequidistant rounded subrugose spiral ridges, each interspace being ornamented by one less prominent but slightly more rugose revolving line on each side of which still finer lines may often be distinguished; above the angle are five revolving lines, less prominent than those on the lower part of the whorl, but alternating in relative size in the same manner as the latter. The penultimate and earlier whorls have about eleven longitudinal waves or low ribs which become most prominent on the angle of the whorls, forming more or less prominent nodes. A prominent sutural riblet is developed on the posterior portion of the whorl. Suture wavy, appressed, distinct. Aperture pyriform; outer lip unknown but probably denticulate. Umbilicus subperforate.

Dimensions.—Longitude (restored), about 55 mm.; latitude, 29 mm.; body whorl, 43 mm.; aperture, 30 mm.; deflection, about 62°.

Notes.—This variety differs from the typical *Pisania fortis* Carpenter, in being broader and in having prominently angulated whorls. The revolving lines in the former are also usually weaker than in the typical form.

Type.—Cat. No. 164959, U.S.N.M.

Locality.—Elsmere Canyon, near Union Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (lower Pliocene). Known only from the type locality where several specimens were found.

PRIENE OREGONENSIS Redfield var. ANGELENSIS, new variety.

Plate L, fig. 11.

Description.—Shell averaging between 80 mm. and 100 mm. in length, fusiform; spire elevated; apex blunt; whorls eight to ten, convex; sculpture of whorls consists of about twenty-four low and rather narrow longitudinal ridges and about seven less prominent, inequidistant spiral ridges, the whole giving the surface a somewhat subdued cancellated appearance; the spiral ridges are augmented by numerous fine spiral striæ; suture deeply impressed, somewhat wavy; faint discontinuous, rounded varices in some specimens; aperture subovate; outer lip not thickened; canal long, narrow, recurved.

Dimensions.—Of imperfect and distorted type; longitude, 71 mm.; latitude, 40 mm.; body whorl, 54 mm.

Notes.—This variety differs from the typical form by its longer, less recurved canal and much less pronounced sculpture. Named after the city of Los Angeles, the type locality.

Type.—Cat. No. 164975, U.S.N.M.

Locality.—Third Street tunnel, Los Angeles, California. (Homer Hamlin.)

Horizon.—Lower Pliocene, probably equivalent of middle Fernando formation.

MUREX ELDRIDGEI, new species.

Plate L, fig. 12.

Description.—Shell broadly fusiform; spire elevated; apex subacute; whorls four, exceedingly convex and ornamented by six prominent convex varices, which cross the whorl diagonally sloping forward up from the base of the whorl to the suture, and each being appressed against the analogous varix of the antecedent whorl in such a way as to give the connected varices a left-handed spiral arrangement, sloping backward down and across the whorls; varices extend full length of body whorl. Surface of whorls and varices ornamented with two or three (six on body whorl) raised lines, between which are finer, more or less beaded raised lines. Suture between the varices deeply impressed, forming pits. Aperture pyriform, narrowing into short, straight canal below; lips smooth.

Dimensions.—Altitude, 24 mm.; latitude, 15 mm.; body whorl, 20 mm.; aperture, 15 mm.

Notes.—This species is closely allied to *Murex incisus* Broderip, but is distinguishable from the latter by its broader form, narrow columella, and simple varices which do not have posteriorly reflexed serrate varices over the sutural pits. Named in honor of the late George Homans Eldridge, of the United States Geological Survey.

Type.—Cat. No. 164955, U.S.N.M.

Locality.—Elsmere Canyon, near Union Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (lower Pliocene).

NASSA HAMLINI, new species.

Plate L, fig. 9.

Description.—Shell about 15 mm. in length, bluntly conical; spire elevated; apex blunt; whorls five or six, quite convex and crossed by several (on the body whorl 12) rather sharp narrow ridges between which are wide interspaces; spiral sculpture consists of four equal,

subequidistant raised lines, of much less prominence than the longitudinal ridges. Suture appressed, distinct, and only slightly wavy. Aperture ovate; outer lip thickened; columellar lip incrusted. Columella slightly twisted, faintly spirally sculptured, and with groove next to body whorl. Canal short.

Dimensions.—Longitude, 15 mm.; latitude, 9 mm.

Notes.—This species is unlike any other West Coast form, being characterized by its blunt apical whorls, convex whorls, deep suture and sharp narrow longitudinal ridges. The type has a glossy surface. Named in honor of Mr. Homer Hamlin, city engineer of Los Angeles, California, to whom we are indebted for preserving the valuable paleontological material taken out of the Third Street tunnel, Los Angeles.

Type.—Cat. No. 164946, U.S.N.M.

Locality.—Third Street tunnel, Los Angeles, California. (Homer Hamlin.)

Horizon.—Lower Pliocene, probably middle Fernando formation.

CYPRÆA FERNANDOENSIS, new species.

Plate L, figs. 8 and 8*a*.

Description.—Shell about 40 mm. in length, pyriform, ventricose, convolute; spire concealed; surface covered with brown enamel, some of which is retained; aperture long and narrow, with a canal at each end, the anterior canal being the longer; outer lip inflected and crenulated with about seventeen teeth; inner lip similarly crenulated.

Dimensions.—Longitude, 40 mm.; latitude, 24 mm.

Notes.—This species, which is doubtless the precursor of *C. spadicea* Gray, is relatively broader, has a relatively broader and less protruding anterior portion to the outer lip, has a relatively broader and more nearly straight aperture, fewer teeth, and has these teeth, especially those on the anterior portion of the inner lip, more evenly spaced, than in *C. spadicea*. Named for the Fernando formation, of which it is supposed to be characteristic.

Type.—Cat. No. 164961, U.S.N.M.

Locality.—Elsmere Canyon, near the Pacific Coast Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (Lower Pliocene).

TURRITELLA COOPERI Carpenter var. FERNANDOENSIS new variety.

Plate LI, fig, 13.

Description.—Shell strong, acute-conic, when perfect probably of twelve or more whorls; early whorls unknown; later whorls angulated both above and below near the suture; surface between the

angles flat or slightly concave and ornamented by four (including those at the angles) prominent spiral ridges; both above the upper angle and below the lower one is a similar ridge; suture quite deeply impressed; base practically flat, faintly spirally sculptured; aperture subquadrate.

Dimensions.—Of the type, an imperfect specimen, altitude, 31 mm.; latitude, 12 mm.; altitude of body whorl, 13 mm.

Notes.—The spiral ribs in this variety are all of about equal prominence while in the typical Pleistocene forms the rib on each angle is much more prominent than those between, the latter being little more than raised lines; the surface of the whorl between the angles is also less concave and the general shape of the shell less slender in var. *fernandoensis* than in typical *cooperi*.

Type.—Cat. No. 164957, U. S. N. M.

Locality.—Elsmere Canyon, near the Pacific Coast Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, California. (Ralph Arnold.)

Horizon.—Middle Fernando formation (Lower Pliocene).

EXPLANATION OF PLATES.

All figures are natural size unless otherwise indicated. Unless otherwise indicated all specimens figured are from California.

PLATE XXXVIII.

Fig. 1. *Venericardia planicosta* Lamarck. Cat. No. 164973, U.S.N.M. Left valve; longitude, 84 mm. Eocene, Little Falls, Washington. This is the most widespread and characteristic Eocene species in the world. Found in the Sespe and Silver Thread districts, Ventura County.

1*a*. View of anterior end of both valves of same.

1*b*. View from above of both valves of same.

2. *Cardium cooperii* Gabb. Cat. No. 164998, U.S.N.M. A decorticated right valve; longitude, 35 mm. Eocene, Rose Canyon, San Diego County. A common species in the Eocene of the West Coast.

2*a*. View of both valves of same specimen from above.

3. *Meretrix hornii* Gabb. Left valve; longitude, 36 mm. Pal. Cal., II, pl. XXX, fig. 78. A common species in the Eocene of the west coast.

4. *Modiolus ornatus* Gabb. Right valve; longitude, 38 mm. Pal. Cal., I, pl. XXIV, fig. 166. Another species found in most Eocene faunas of the West Coast.

PLATE XXXIX.

Figures 3, 3*a*, 3*b*, 5, and 7 are copied from Pal. Cal., I and II.

Fig. 1. *Pecten* (*Chlamys*) *calkinsi* Arnold. Collection Univ. California. An imperfect left valve; altitude 45 mm. Eocene, Sisar Creek, Ventura County.

2. Same species as fig. 1. Imperfect right valve; altitude, 29 mm. Same locality and collection as fig. 1.

3. *Pecten* (*Propeamusium*) *interradiatus* Gabb. Left valve; altitude, 25 mm. Eocene shales at New Idria, San Benito County, and in Silver Thread district, Ventura County.

Fig. 3*a*. Interior of left valve of same specimen.

3*b*. Outline of ears of right valve of same species.

4. *Glycymeris veatchii* Gabb var. *major* Stanton. Cat. No. 165003, U.S.N.M. Imperfect left valve; longitude, 30 mm. Eocene, Rock Creek, Los Angeles County. Found in the lower Eocene (Martinez formation) in California.

5. *Cardium brewerii* Gabb. Right valve; longitude, 51 mm. Common in the Eocene (Tejon formation and equivalents).

6. *Teredo* sp. Cat. No. 164972, U.S.N.M. Imperfect section of tube, lateral view; diameter, 11 mm. Eocene, Sisar Creek, Ventura County.

6*a*. Same species as fig. 6. Cat. No. 164972, U.S.N.M. Cross section of a crushed specimen; maximum diameter, 15 mm. Same locality as fig. 6.

7. *Fusus remondii* Gabb. Front view; altitude, 41 mm. Common in Eocene (Tejon formation and equivalents) on West Coast.

7*a*. Magnified view of surface of original of fig. 7.

8. *Amauropsis alveatus* Conrad. Cat. No. 165000, U.S.N.M. Front view of partially decorticated specimen; altitude 32 mm. Eocene, Rose Canyon, San Diego County. A characteristic Eocene gasteropod in California.

9. *Morio* (*Sconsia*) *tuberculatus* Gabb. Cat. No. 164999, U.S.N.M. Front view of an imperfect and decorticated specimen; altitude 27 mm. Eocene, Rose Canyon, San Diego County. Perfect specimens have an anteriorly plicate plate over the inner lip; outer lip crenulate; revolving lines on surface.

10. *Cylichna costata* Gabb. Cat. No. 165001, U.S.N.M. Front view of slightly imperfect specimen; altitude 18 mm.; twice natural size. Eocene, Rose Canyon, San Diego County. Common in the Eocene (Martinez and Tejon formations and equivalents) in California.

PLATE XL.

Fig. 1. *Pecten* (*Lyropecten*) *bowersi* Arnold. Collection Univ. California. Holotype. Right valve; altitude 150 mm.; about two-thirds natural size. Lower Miocene, Santa Inez Mountains, Santa Barbara County. Also abundant at same horizon in Santa Monica Mountains and elsewhere. The left valve of this species is more convex than the right, but otherwise is very similar.

2. *Ostrea titan* Conrad. Cat. No. 164987, U.S.N.M. Side view of both valves; altitude of large valve 131 mm.; two-thirds natural size. Lower Miocene, 3 miles south of Calabasas, Los Angeles County. This species is found in both the upper and lower Miocene, and often grows to a length of 20 inches (500 mm.). (See Plate XLV, fig. 2.)

3. *Purpura edmondi*, new species. Cat. No. 164983, U.S.N.M. Holotype. Aperture view; altitude 19 mm.; about $1\frac{1}{3}$ times natural size. Lower Miocene, 3 miles south of Calabasas, Los Angeles County.

3*a*. Reverse view of same specimen as fig. 3; same enlargement.

4. *Chlorostoma* (*Omphalius*) *dalli*, new species. Cat. No. 164984, U.S.N.M. Holotype. Aperture view; latitude 12.5 mm.; $1\frac{1}{3}$ times natural size. Lower Miocene, 3 miles south of Calabasas, Los Angeles County. A common species in this horizon.

4*a*. Top view of same specimen.

4*b*. Base view of same specimen.

5. *Chlorostoma* (*Omphalius*) *dalli* var. *inornatus*, new variety. Cat. No. 164986, U.S.N.M. Holotype. Top view; latitude 13.5 mm.; $1\frac{1}{3}$ times natural size. Same locality as fig. 4.

6. *Chlorostoma* (*Omphalius*) *dalli* var. *subnodosus*, new variety. Cat. No. 164985, U.S.N.M. Holotype. Top view; latitude 13 mm.; $1\frac{1}{3}$ times natural size. Same locality as fig. 4.

6*a*. Base view of same specimen as fig. 6.

Fig. 7. *Cerithium topangensis*, new species. Cat. No. 164976, U.S.N.M. Holotype. Aperture view of imperfect specimen; longitude 23 mm.; 1½ times natural size. Lower Miocene, 3 miles south of Calabasas, at head of Topanga Canyon, Los Angeles County. A common species at the type locality.

8. *Cerithium topangensis*, new species. Cat. No. 164976, U.S.N.M. Cotype. Aperture view of imperfect specimen; longitude 13 mm.; 1⅓ times natural size. Same locality as fig. 7.

9. *Cancellaria* cf. *condoni* Anderson. Cat. No. 164981, U.S.N.M. Back view of imperfect specimen; altitude 21 mm.; 1⅓ times natural size. Lower Miocene, 3 miles south of Calabasas, Los Angeles County. This species appears to range from the San Joaquin Valley to the Santa Monica Mountains in the lower Miocene.

PLATE XLI.

Fig. 1. *Pecten* (*Lyropecten*) *magnolia* Conrad. Collection Univ. California. Imperfect right valve; altitude 14.5 mm.; about two-thirds natural size. Lower Miocene, Vaqueros formation, Ojai Valley, Ventura County. Characteristic of the lower Miocene throughout central and southern California. The left valve has narrow, more rounded ribs.

2. *Pecten* (*Lyropecten*) *estrellanus* Conrad. Cat. No. 164851, U.S.N.M. Left valve; altitude 97 mm.; about two-thirds natural size. Upper Miocene, Wildhorse Canyon, Monterey County. This species is usually abundant in both the lower and upper Miocene faunas of central and portions of southern California. Ribs of right valve broader and anterior ear notched; otherwise similar to left.

3. *Drillia* sp. Cat. No. 164977, U.S.N.M. Back view; longitude 13.5 mm.; about 1⅓ times natural size. Lower Miocene, head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County.

4. *Macron merriami*, new species. Cat. No. 164982, U.S.N.M. Holotype. Aperture view; longitude 23 mm.; about 1⅓ times natural size. Lower Miocene, same locality as fig. 3. This species appears to range over central and southern California in the lower Miocene.

4*a*. Back view of same specimen.

5. *Sigaretus perrini*, new species. Cat. No. 164979, U.S.N.M. Holotype. Aperture view of partially decorticated and imperfect specimen; altitude 18.5 mm.; about 1⅓ times natural size. Lower Miocene, same locality as fig. 3.

6. *Turbo topangensis*, new species. Cat. No. 164980, U.S.N.M. Holotype. Aperture view; altitude 18.5 mm.; about 1⅓ times natural size. Lower Miocene, same locality as fig. 3.

6*a*. Top view of same specimen.

6*b*. Base view of same specimen.

PLATE XLII.

Fig. 1. *Pecten* (*Amusium*) *lompocensis* Arnold. Cat. No. 164852, U.S.N.M. Paratype. Interior view, showing internal liræ; altitude 90 mm.; about two-thirds natural size. Lower Miocene, Ojai Valley, Ventura County. This form, so far as known, is confined to the lower Miocene of Santa Barbara and Ventura counties.

2. *Ostrea eldridgei*, new species. Cat. No. 164986, U.S.N.M. Holotype. View of exterior of larger valve; altitude 14.7 mm.; two-thirds natural size. Lower Miocene, supposed equivalent of Vaqueros formation, Elkins ranch, east of Grimes Canyon, south of Fillmore, Ventura County.

2*a*. Lateral view of same specimen.

Fig. 3. *Scutella fairbanksi* Merriam. Cat. No. 164963, U.S.N.M. View of top, showing details; maximum diameter 36 mm.; $1\frac{1}{3}$ times natural size. Lower Miocene, supposed equivalent of Vaqueros formation, near Torrey Canyon wells, southwest of Piru, Ventura County; abundant. This species is also found near the base of the Vaqueros formation in the Sespe district. Supposed to be characteristic of the lower Miocene.

PLATE XLIII.

Fig. 1. *Venus* (*Chione*) *temblorensis* Anderson. Cat. No. 164989, U.S.N.M. Exterior of imperfect right valve; longitude 80 mm. Lower Miocene, head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County. Usually abundant in the lower Miocene; a nearly related, possibly identical, form found in the upper Miocene.

1*a*. Top view of same specimen.

2. *Mytilus mathewsonii* Gabb var. *expansus*, new variety. Cat. No. 164968, U.S.N.M. Holotype. Right valve; altitude 10.5 mm. Lower Miocene, supposed equivalent of the Vaqueros formation, near Torrey Canyon wells, southwest of Piru, Ventura County. This species is usually found in the faunas of the lower Miocene through central and southern California.

3. *Scutella fairbanksi* Merriam. Cat. No. 164963, U.S.N.M. Same locality as fig. 2, but possibly at a somewhat lower horizon.

4. *Ocinebra topangensis*, new species. Cat. No. 164995, U.S.N.M. Holotype. Back view; altitude 59 mm. Lower Miocene, Topanga Canyon, 3 miles south of Calabasas, Los Angeles County. So far known only from this horizon.

PLATE XLIV.

Fig. 1. *Pecten* (*Lyropecten*) *crassicardo* Conrad. Cat. No. 164967, U.S.N.M. Exterior of valve, showing characteristic sculpture; altitude 90 mm. Lower Miocene, Ojai Valley, Ventura County. This species ranges through the lower and upper Miocene, being commoner in the former in southern California, in the latter in central California. It is sometimes more convex than the figured specimen, and often shows concentric undulations of the disk.

2. *Pecten* (*Chlamys*) *sespeensis* var. *hydei* Arnold. Collection of Delos Arnold. Type. Right valve, ear missing; altitude 46 mm. Lower Miocene, Lynchs Mountain, San Luis Obispo County. Found also in the Vaqueros formation, Little Sespe Creek, and, with *Mytilus mathewsonii* Gabb, in supposed equivalents of the Vaqueros formation near the Torrey Canyon wells, Ventura County.

3. *Pecten* (*Pseudamusium*) *peckhami* Gabb. Cat. No. 164839, U.S.N.M. Right and left valves in matrix; altitude of largest 17 mm. Monterey shale (middle Miocene), southeast of Pinole, Contra Costa County. The type of this species came from the Ojai Valley, Ventura County. It is the commonest form in the shales of the middle Miocene (Monterey, Modelo, and equivalent formations) and is also known from the Oligocene in the Santa Cruz Mountains.

4. *Neverita callosa* Gabb. Cat. No. 164992, U.S.N.M. View from above, specimen slightly tilted; maximum latitude 44 mm. Lower Miocene, head of Topanga Canyon, 3 miles south of Calabasas, Los Angeles County. Ranges through the Miocene. Common in the lower Miocene of southern San Joaquin Valley and the Santa Monica Mountains.

4*a*. View of base and aperture of same specimen, showing characteristic shape of callous.

PLATE XLV.

Fig. 1. *Pecten* (*Hinnites*) *giganteus* Gray. Cat. No. 164965, U.S.N.M. Exterior of right valve; altitude 90 mm. Lower Miocene, supposed equivalent of Vaqueros formation, gulch east of Wiley Canyon, southwest of Piru, Ventura County. A very variable species, ranging from the lower Miocene to the Recent fauna.

2. *Ostrea titan* Conrad. Cat. No. 164987, U.S.N.M. View of exterior of larger valve; altitude 131 mm. Lower Miocene, 3 miles south of Calabasas, Los Angeles County. A common form in the upper and lower Miocene; often grows to a length of 20 inches (500 mm.) or more. (See Plate XL, fig. 2.)

3. *Trochita costellata* Conrad. Cat. No. 164994, U.S.N.M. View from above; maximum diameter 38 mm. Same locality as fig. 2. Common in the Miocene.

4. *Phacoides richthofeni* Gabb. Cat. No. 164978, U.S.N.M. Right valve; altitude 17.5 mm. Same locality as fig. 2.

5. *Balanus concavus* Bronn. Cat. No. 164971, U.S.N.M. Type. Lateral view; maximum latitude 26 mm. Lower Miocene, Little Sespe Creek, Ventura County. A very common species in this horizon.

5*a*. Top view of same species.

PLATE XLVI.

Fig. 1. *Pecten* (*Chlamys*) *sespeensis* Arnold. California State Mining Bureau. Cotype. Portion of mold of interior of right valve; altitude 50 mm. Lower Miocene, Vaqueros formation, Sespe Canyon, Ventura County. A common species at the type locality; also found elsewhere in central and southern California in the lower Miocene.

1*a*. Mold of interior of left valve of same specimen.

2. *Pecten* (*Chlamys*) *sespeensis* Arnold. California State Mining Bureau. Plastotype. Cast of exterior of slightly imperfect left valve (young); altitude 18 mm. Same locality as fig. 1.

3. *Pecten* (*Lyropecten*) *vaughani* Arnold. Collection of Delos Arnold. Type. Right valve; altitude 37 mm. Lower Miocene, supposed equivalent of Vaqueros formation, Ojai Valley, Ventura County.

3*a*. View of left valve of same specimen.

4. *Dosinia ponderosa* Gray. Cat. No. 164988, U.S.N.M. Imperfect right valve; altitude 80 mm. Lower Miocene, 3 miles south of Calabasas, Los Angeles County. A common species from the lower Miocene to the Recent southern fauna of the west coast.

5. *Pleurotoma* (*Bathytoma*) *keepi*, new species. Cat. No. 164993, U.S.N.M. Holotype. Back view of imperfect specimen. Same locality as fig. 4. Found also in this horizon at several localities in southern San Joaquin Valley.

PLATE XLVII.

Fig. 1. *Arca camulocnsis* Osmont. California State Mining Bureau. Holotype. Right valve; altitude 89 mm. Fernando formation, lower Pliocene or upper Miocene, 1 mile north of Camulos, Ventura County. So far as known this species is characteristic of the lower horizon of the Fernando formation. Also reported from the Puente Hills.

1*a*. End view of same specimen as fig. 1.

1*b*. Portion of surface of same specimen as fig. 1, enlarged, showing nodose ribs.

PLATE XLVIII.

Fig. 1. *Arca multicostata* Sowerby. Cat. No. 12574, U.S.N.M. Right valve; longitude 101 mm. Recent, San Diego. Found in the lower Pliocene (Fernando formation) in the Puente Hills, Orange County, and in the vicinity of Los Angeles.

2. *Cardium quadrigenarium* Conrad, var. *fernandoensis*, new variety. Cat. No. 164947, U.S.N.M. Holotype. Imperfect left valve; longitude 58 mm. Lower Pliocene (Fernando formation), Elsmere Canyon, near Newhall, Los Angeles County. A common variety in the lower Pliocene. The typical form with 44 ribs and less obliquity is found in the Recent.

2*a*. View of umbos of same specimen from above.

3. *Arca trilineata* Conrad. Cat. No. 164948, U.S.N.M. Right valve of medium-sized specimen; longitude 40 mm. Same locality as fig. 2. A common species in the Pliocene of California. Also appears to extend down as far as the middle Miocene (Monterey).

3*a*. Umbos and hinge area of same specimen viewed from above.

4. *Arca trilineata* Conrad. Cat. No. 164948, U.S.N.M. Portion of an adult left valve, showing the more complex sculpture of the ribs in the later stages of growth; altitude 60 mm. Same locality as fig. 2.

5. *Leda taphria* Dall. Cat. No. 164952, U.S.N.M. Right valve; longitude 36 mm.; twice natural size. Same locality as fig. 2. This species is common from the Pliocene to the Recent fauna in the California province.

5*a*. View of umbos of same specimen from above.

6. *Neverita recluziana* Petit. Cat. No. 164960, U.S.N.M. Back view; latitude 25 mm. Same locality as fig. 2. A common species from the Pliocene to the Recent fauna; also probably occurs in the Miocene.

PLATE XLIX.

Fig. 1. *Ostrea veatchii* Gabb. Cat. No. 153827, U.S.N.M. Exterior of valve; altitude 90 mm. Lower Pliocene, San Diego. An abundant and characteristic species in many of the Pliocene localities from southern California to Cerros Island, off Lower California.

2. *Callista* (*Amiantis*) *callosa* Conrad. Cat. No. 164953, U.S.N.M. Imperfect left valve; altitude 50 mm. Lower Pliocene (Fernando formation), Elsmere Canyon, near Newhall, Los Angeles County. Base evenly rounded in perfect specimens. Common from Pliocene to Recent.

3. *Callista subdiaphana* Carpenter. Cat. No. 164951, U.S.N.M. Imperfect right valve; longitude 41 mm. Same locality as fig. 2. Abundant in the Pliocene and also found in the Recent.

4. *Terebratalia smithi* Arnold. Cat. No. 164977, U.S.N.M. Pedicle valve; longitude 42 mm. Pliocene, Temescal Canyon, 3 miles north of Santa Monica, Los Angeles County. Known only from the Pliocene. A somewhat variable species.

4*a*. View of brachial valve of same specimen.

5. *Terebratalia smithi* Arnold. Cat. No. 164977, U.S.N.M. Pedicle valve; longitude 29 mm. Same locality as fig. 4. More prominent ribbing than specimen shown in fig. 4.

5*a*. View of brachial valve of same specimen.

6. *Terebratalia occidentalis* Dall. Cat. No. 164996, U.S.N.M. Brachial valve; longitude 40 mm. Same locality as fig. 4. This species is most variable, as is evidenced by this and the following figures, which show a series collected at one locality. Found in the lower Pliocene (and possibly upper Miocene).

Fig. 7. Same species and locality as fig. 6. Pedicle valve; longitude 29 mm.
7*a*. View of brachial valve of same specimen.
8. Same species and locality as fig. 6. Pedicle valve; longitude 22 mm.
8*a*. View of brachial valve of same specimen.
9. Same species and locality as fig. 6. Pedicle valve of a less rugose variety; longitude 21 mm.
9*a*. View of brachial valve of same specimen.

PLATE L.

Fig. 1. *Mya truncata* Linnæus. Cat. No. 164950, U.S.N.M. Left valve; longitude 46 mm. Pliocene (Fernando formation), Elsmere Canyon, near Newhall, Los Angeles County. Found also in the Recent fauna of the Arctic regions.
2. *Trochita filosa* Gabb. Cat. No. 164949, U.S.N.M. Slightly imperfect specimen viewed from above; maximum diameter 20 mm.; twice natural size. Same locality as fig. 1. Also found in the upper Miocene.
2*a*. Same specimen. View from the side.
3. *Fissuridea murina* Carpenter. Cat. No. 164945, U.S.N.M. Specimen viewed from above; longitude 14.5 mm.; twice natural size. Lower Pliocene, Third street tunnel, Los Angeles. Also found in the Pleistocene and Recent fauna of the coast.
3*a*. Same specimen; view from the side.
4. *Cancellaria fernandoensis*, new species. Cat. No. 164956, U.S.N.M. Holotype. Back view of imperfect specimen; altitude 17 mm.; twice natural size. Same locality as fig. 1. A similar or identical form was found in the Pliocene of the San Diego well.
5. *Tritonium* sp. Cat. No. 164954, U.S.N.M. Back view of imperfect specimen; altitude 20 mm.; twice natural size. Same locality as fig. 1.
6. *Pisania fortis* Carpenter var. *angulata*, new variety. Cat. No. 164959, U.S.N.M. Paratype. Aperture view of imperfect young; altitude 30 mm. Same locality as fig. 1. A rather common species in the Pleistocene and Pliocene of central and southern California.
7. *Pisania fortis* Carpenter var. *angulata*, new variety. Cat. No. 164958, U.S.N.M. Holotype Aperture view of imperfect adult; altitude 49 mm. Same locality as fig. 1.
8. *Cypræa fernandoensis*, new species. Cat. No. 164961, U.S.N.M. Holotype. View from back; longitude 40 mm. So far known only from same locality as fig. 1.
8*a*. Aperture view of same specimen.
9. *Nassa hamlini*, new species. Cat. No. 164946, U.S.N.M. Holotype. Aperture view of imperfect specimen; longitude 15 mm. Same locality as fig. 3.
10. *Chrysodomus* cf. *arnoldi* Rivers. Cat. No. 164962 U.S.N.M. Back view of imperfect specimen. Same locality as fig. 1. Known also from the Pleistocene of San Pedro, Los Angeles County.
11. *Priene oregonensis* Redfield var *angelensis*, new variety. Cat. No. 164975, U.S.N.M. Holotype. Back view of imperfect and slightly contorted specimen; longitude 71 mm. Same locality as fig. 3. Common in the lower Pliocene of the Pacific coast. It is the precursor of the recent *Priene oregonensis* Redfield.
12. *Murex eldridgei*, new species. Cat. No. 164955, U.S.N.M. Holotype. Back view; longitude 24 mm.; twice natural size. Known only from the same locality as fig. 1. Near the Recent *M. incisus* Broderip.
13. *Pecten* (*Chlamys*) *hastatus* Sowerby var. *strategus* Dall. Collection of Delos Arnold. Left valve; altitude 36 mm. Pliocene, Santa Barbara. Also found in the Pliocene of southern California.

Fig. 14. *Pecten (Chlamys) bellilamellatus* Arnold. Collection of Delos Arnold. Holotype. Right valve; altitude 18 mm. Pliocene, Pacific Beach, San Diego. Known only from this horizon at this locality.

PLATE LI.

Fig. 1. *Turritella pachecoensis* Stanton. Cat. No. 165002, U.S.N.M. Back view of imperfect specimen; altitude 59 mm. Eocene, Rock Creek, Los Angeles County. This species is supposed to be characteristic of the Martinez formation (lower Eocene).

2. *Turritella uvasana* Conrad. Cat. No. 164974, U.S.N.M. Wax cast, back view; altitude 41 mm. Sespe Canyon, Ventura County. Supposed to be characteristic of the Tejon formation (middle Eocene).

3. *Turritella uvasana* Conrad. Cat. No. 165004, U.S.N.M. Back view of imperfect specimen; altitude 44 mm. Eocene, Rose Canyon, San Diego County.

4. *Turritella ineziana* Conrad (+ *T. hoffmanni* Gabb). Cat. No. 164964, U.S.N.M. Lower Miocene, supposed equivalent of the Vaqueros formation, Chaffee Canyon, southwest of Piru, Ventura County. Supposed to be characteristic of the lower Miocene; found from San Mateo to San Diego counties.

5. *Turritella ineziana* Conrad. Cat. No. 164969, U.S.N.M. Back view of imperfect specimen; altitude 36 mm. Tar Creek, north of Fillmore, Ventura County. Common in the Vaqueros formation, but good specimens are hard to obtain.

6. *Turritella ineziana* Conrad var. *sespecnsis*, new variety. Cat. No. 164970, U.S.N.M. Holotype. Aperture view of imperfect specimen; altitude 34 mm. Same locality as fig. 5.

7. *Turritella ocoyana* Conrad. Cat. No. 164990, U.S.N.M. Back view of imperfect large specimen; altitude 60 mm. Topanga Canyon, 3 miles south of Calabasas, Los Angeles County. Supposed to be characteristic of the lower Miocene. Common in central and southern California.

8. Same species and locality; altitude 58 mm.

9. Same species and locality; altitude 32 mm.; upper whorls.

10. *Turritella variata* Conrad. Cat. No. 164991, U.S.N.M. Back view of imperfect specimen; altitude 34 mm. Same locality as fig. 7. Supposed to be characteristic of the lower Miocene; so far known only in Fresno County and south.

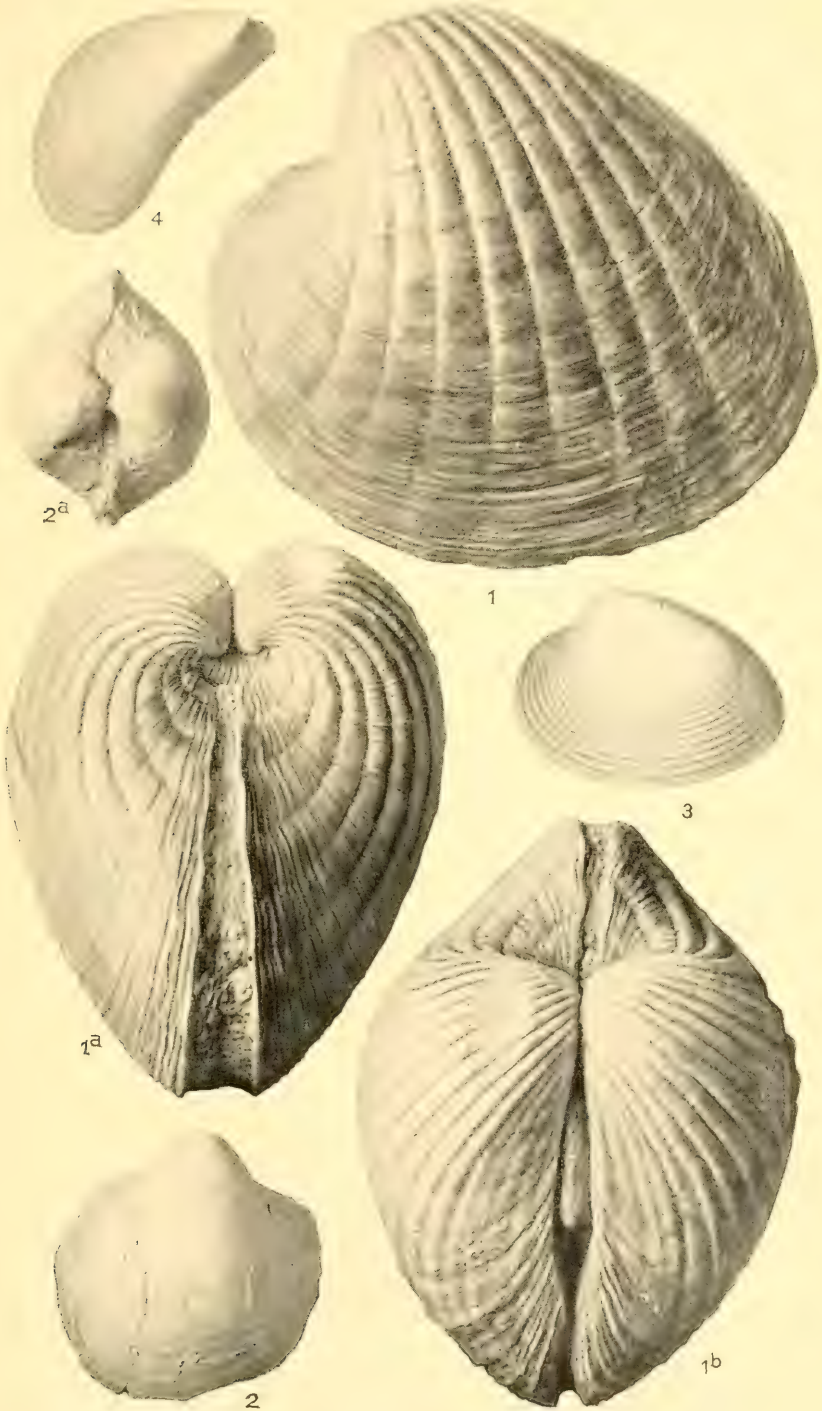
11. Same species and locality; slender variety; altitude 59 mm.

12. Same species and locality; broad variety; altitude 43 mm.

13. *Turritella cooperi* Carpenter (var.) *fernandoensis*, new variety. Cat. No. 164957, U.S.N.M. Type. Aperture view of imperfect specimen; altitude 31 mm. Lower Pliocene, Fernando formation, Elsmere Canyon, near Newhall, Los Angeles County. A common form in the lower Pliocene of southern California.

14. *Turritella cooperi* Carpenter. Collection of Delos Arnold. Aperture view of typical form. Lower Pleistocene, lower San Pedro formation, Deadman Island, San Pedro, Los Angeles County. Common in the Pliocene and lower Pleistocene from Ventura County southward.

15. *Turritella jewetti* Carpenter. Collection of Delos Arnold. Typical form, aperature view; altitude 70 mm. Same locality and horizon as fig. 14; geologic and geographic range also about the same.



EOCENE PELECYPODA.

FOR EXPLANATION OF PLATE SEE PAGE 539.

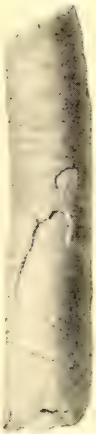

3a


3b

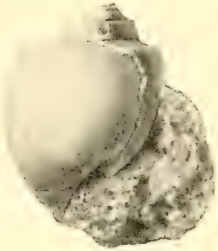

3


7a


7

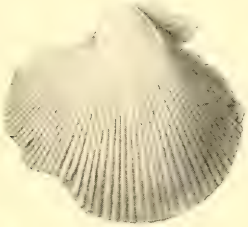

6

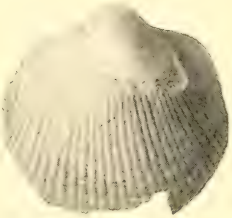

9


8


10


6a


2


4


5


1

EOCENE PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGES 539, 540.

MIOCENE PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGES 540, 541.

MIOCENE PELECYPODA AND GASTEROPODA.

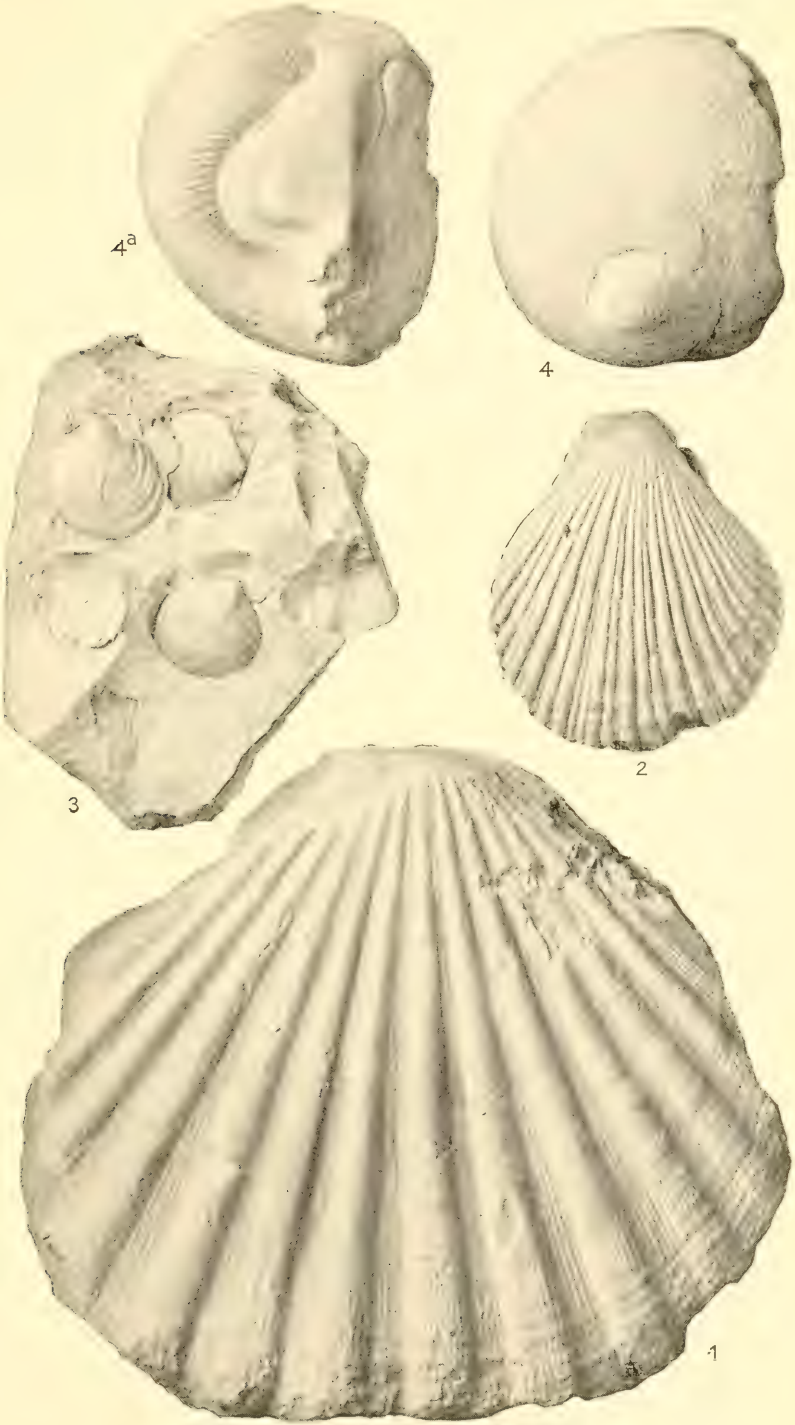
FOR EXPLANATION OF PLATE SEE PAGE 541.

MIOCENE ECHINOIDEA AND PELECYPODA.

FOR EXPLANATION OF PLATE SEE PAGES 541, 542.

MIOCENE ECHINOIDEA, PELECYPODA, AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGE 542.

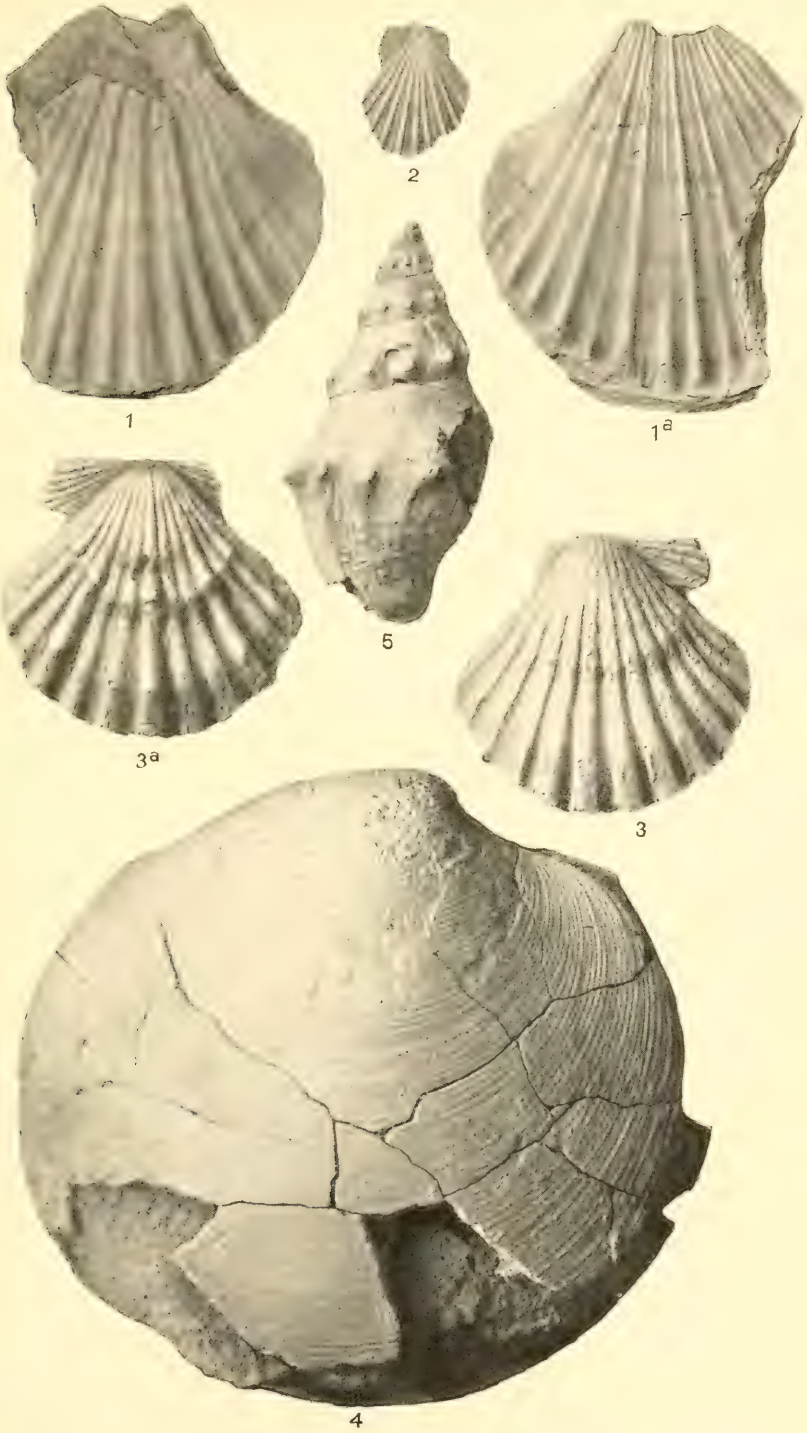


MIOCENE PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGE 542.

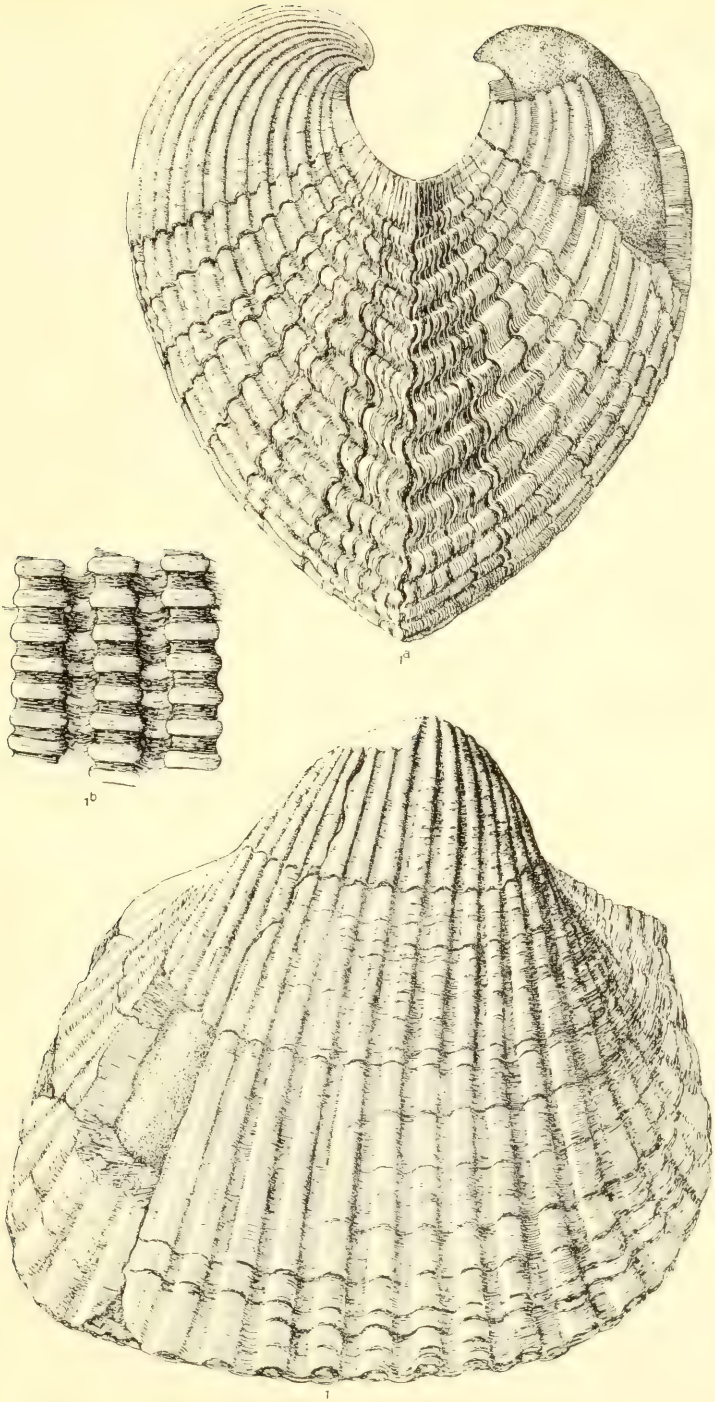
MIOCENE PELECYPODA, GASTEROPODA, AND CRUSTACEA.

FOR EXPLANATION OF PLATE SEE PAGE 543.



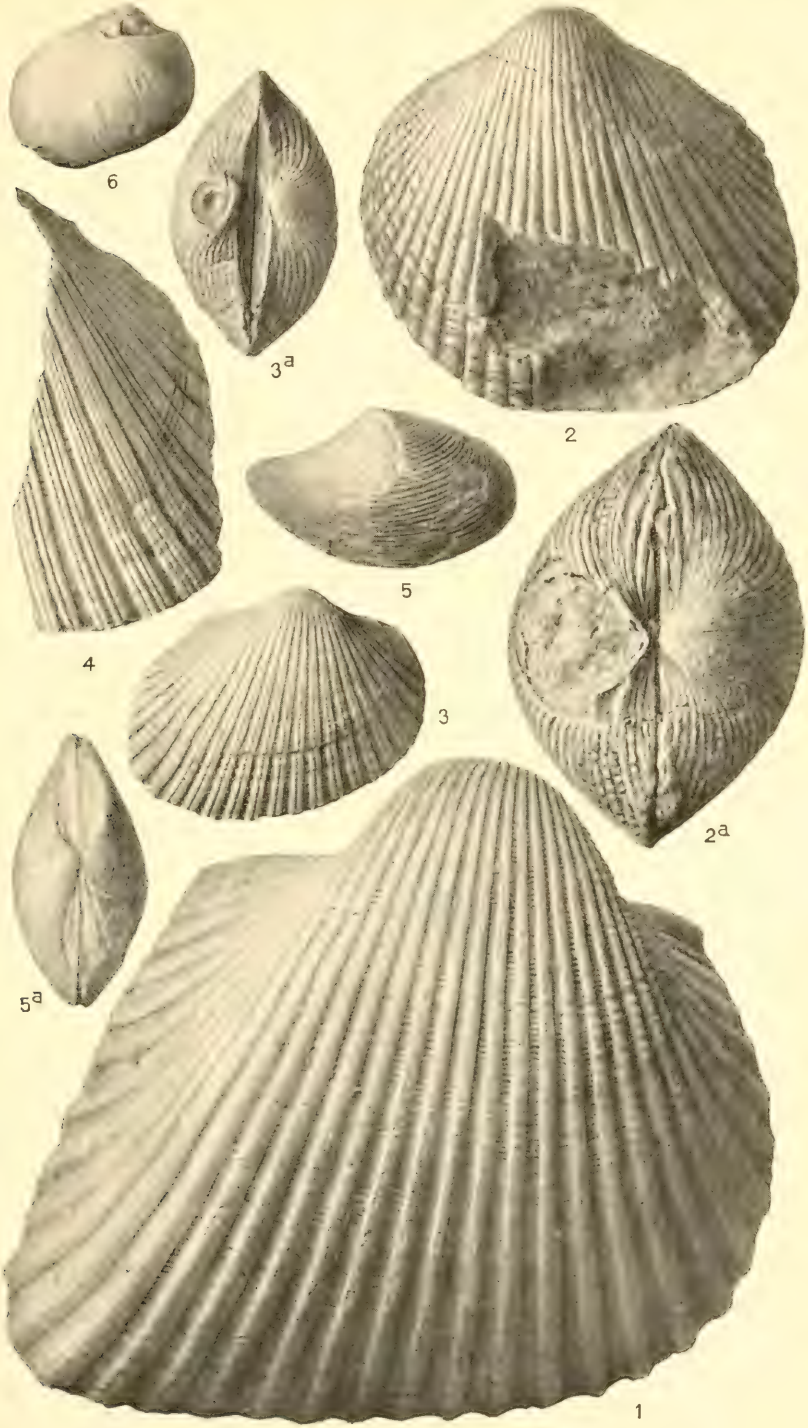
MIOCENE PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGE 543.



PLIOCENE ARCAS.

FOR EXPLANATION OF PLATE SEE PAGE 543.



PLIOCENE PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGE 544.

PLIOCENE BRACHIOPODA AND PELECYPODA.

FOR EXPLANATION OF PLATE SEE PAGES 544, 545.

PLIOCENE PELECYPODA AND GASTEROPODA.

FOR EXPLANATION OF PLATE SEE PAGES 545, 546.

TERTIARY TURRITELLAS.

FOR EXPLANATION OF PLATE SEE PAGE 546.

ON A PECULIAR FORM OF METAMORPHISM IN SILICEOUS SANDSTONE.

By George P. Merrill,

Head Curator, Department of Geology, U. S. National Museum.

It will be remembered that in 1891 attention was called to a crater-like depression in unaltered sedimentary rocks some twelve miles southeast of Canyon Diablo, Arizona, by the finding of a large number of masses of meteoric iron in the immediate vicinity. Subsequently the possible origin of the depression, or crater, was made a matter of investigation by Mr. G. K. Gilbert, of the U. S. Geological Survey, who gave his results in his presidential address before the Geological Society of Washington, in 1896, under the caption of The Origin of Hypotheses.

With the question of the origin of the crater the present paper has little to do. It is sufficient to say that Mr. Gilbert, after discussing various hypotheses, was led to regard that of an origin through explosive volcanic action as most plausible. This view has recently been discussed by Messrs. D. M. Barringer and B. C. Tilghman, of Philadelphia,[a] who have undertaken a series of investigations based on the theory that the depression is due to the impact of a gigantic meteorite.

As is well known, the surface rock over a large part of the region is an arenaceous limestone, known as the Aubrey limestone, which has, according to Mr. Barringer, a thickness of some 350 feet. Immediately underlying this is a light gray sandstone from 450 to 500 feet in thickness. A peculiar and apparently very local form of metamorphism of this rock is the excuse for the present paper.

The sandstone (Cat. No. 76834 U.S.N.M.) in its original and prevailing type is of a light gray color, distinctly saccharoidal and, in the walls of the crater, very friable, being in small masses easily disintegrated in the hands. Under the microscope it is found to be composed

[a] Coon Mountain and its Crater, Proc. Acad. Nat. Sci. Phila., December, 1905. Issued March 1, 1906.

of well-rounded quartz granules with an occasional grain of a plagioclase feldspar, and a little dust-like material in the interstices, but the amount of interstitial material of any kind is very small. The general structure of the stone is shown in fig. 1 of Plate LII. This type passes into what may be called the first phase of the metamorphism—an almost chalky white rock—(Cat. No. 76835 U.S.N.M.), still retaining the granular character and much of the original structure of the sandstone, and crushing readily between the thumb and fingers. Under the microscope this type shows interesting structural changes which are only in part brought out by the photomicrograph reproduced in fig. 2 of Plate LII. A portion of the quartz granules retain their original characteristics. A larger portion are crushed and more or less distorted, though retaining their limpidity and high polarization colors. In many instances two adjacent granules are crushed and fractured at point of contact as though they had been struck a sharp blow with a hammer. This crushing has at times been carried so far that the rock is reduced to a fine sand (Cat. No. 76840 U.S.N.M.), each particle of which is as sharply angular as though disintegrated by a blast of dynamite (see fig. 4, Plate LII).[a] Of greater significance from the present standpoint is the presence in the still firm rock of a large number of granules which are so completely changed as to give rise to forms at first glance scarcely recognizable as quartzes at all. A description of these is given in the discussion of the next phase of the metamorphism.

In this second and very complete phase of metamorphism the original granular structure of the sandstone has almost wholly disappeared, as have also the original lines of bedding (Cat. No. 76837, U.S.N.M). The rock is chalk-white to cream-yellow in color, quite hard, though in thin fragments readily broken between the thumb and fingers, and lacks entirely the arenaceous structure. It resembles the decomposed chert quarried at Seneca, Missouri, under the name of tripoli, more than any other rock that the writer can call to mind, although on casual inspection it might readily pass for an old siliceous or calcareous sinter. This material, Mr. Tilghman writes, occurs sporadically throughout the pulverulent material, of which it constitutes some 2 per cent in bulk and in fragments from the fraction of an inch to 10 or 12 feet in diameter. In one instance the drill passed through a mass of it some 50 feet in thickness at a depth of 500 feet below the surface. In the mass this variety shows an uneven platy structure extending directly across the original, almost obliterated, lines of bedding. Under the microscope this phase exhibits certain features new to the writer, at least, and which are quite at variance with our ideas of the stable character of quartz sand. The general structure is shown in fig. 5 of Plate LII. A more highly magnified

[a] This is the material referred to as "Silica" by Messrs. Barringer and Tilghman, and of which there are said to be "millions of tons."

though less well-defined section is shown in fig. 3. At first glance such would be pronounced to be a holocrystalline rock. It is, in fact, an aggregate of closely interlocking quartz granules with low and very uniform relief, dull colors of polarization, and in the majority of instances a marked rhombohedral cleavage. So striking is this feature that at first the true nature of the mineral was not recognized. Extinctions are often undulatory, indicating a condition of molecular strain, and the cleavage lines are themselves at times more or less wavy. The appearance indeed is such as to suggest that the granules have been subjected to pressure while in a putty like or plastic condition. With a high power and between crossed Nicols (fig. 3 of Plate LII) the rock is seen to be not holocrystalline, but to contain comparatively small colorless interstitial areas, showing by ordinary light a fibrous structure, but which are for the most part completely isotropic between crossed Nicols, and which the chemical analysis suggests may be opal. From this condition the rock passes rarely through more or less vesicular to highly pumiceous forms (Cat. Nos. 76839 and 76840), showing to the unaided eye all the features of an obsidian pumice, but of a white color. This under the microscope is resolved into a colorless vesicular glass, more or less muddied through dust-like material and showing here and there residual particles of unaltered quartz. The glass does not, however, resemble the glass of a pumice, nor is it like that obtained by the artificial fusion of quartz in the geophysical laboratories of the Carnegie Institution. So far as the writer's observations go, it more closely resembles fulgurite glass, formed by the lightning striking in siliceous sand. This form, it is well to note, is quite rare, the material being first met with in what Mr. Barringer has designated as shaft No. 2, and at a depth of 130 feet. A few small pieces were found in digging the open cuts outside of the crater and but one piece lying out on the surface.

Chemical tests on (I) the unaltered sandstone; (II) what may be called the crystalline variety, the finely laminated stone compared to a decomposed chert, and (III) the pumice, gave Mr. Wirt Tassin results as below:

(I) Unaltered sandstone	SiO_2	99.29
	Undet	.71
		100.00
(II) Altered sandstone	Si_2O	98.63
	Al_2O_3	0.18
	Fe_2O_3	0.10
	Ign	0.99
	Loss at 100°	0.30
		100.20

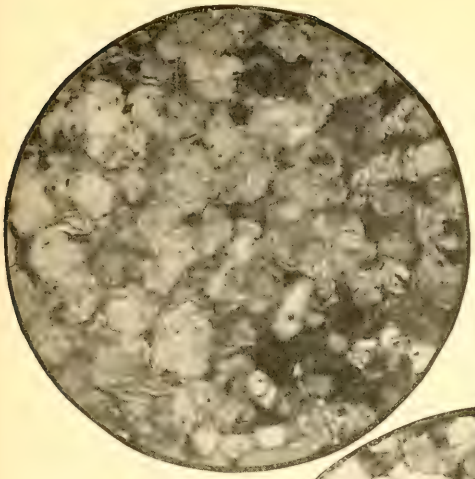
(III) Pumiceous variety	SiO_2	95.22
	Al_2O_3	0.59
	Fe_2O_3	0.19
	CaO	1.99
	Ign	1.20
	Loss at 100°	0.40
		99.59

A part of the lime in Analysis III was there as a mechanically admixed carbonate. The high ignition (0.99) in II would suggest that a part of the silica is in the condition of opal, as already noted. Eliminating the ignition and the free calcium carbonate in III, it is evident that there is no essential chemical difference in the three samples. They vary as little as would probably three independent analyses of any one of the types from slightly different sources.[a]

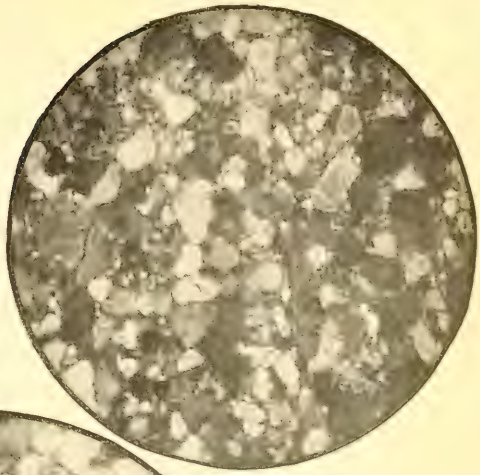
As to the exciting cause of this metamorphism. So far as the writer has information, no more satisfactory theory has been advanced than that of the Messrs. Barringer and Tilghman,[b] who ascribe it to the impact and incidental heat of an enormous mass of meteoric iron which constituted a portion of the well-known Canyon Diablo fall. Startling as it may seem, the writer, without intending to commit himself in any way, has to acknowledge that it must at least receive consideration, for the simple reason that nothing else seemingly worthy of consideration presents itself. That there must have been intense heat, and that, too, only for a brief period, is certainly manifest. The force of impact of an ordinary meteoric mass, as is well known, is not great and the depth of penetration but slight. The majority of those that come to our earth are, however, following it in its orbit about the sun, and their speed on entering our atmosphere is, so far as determined, only some 3 to 10 miles a second. If, however, we conceive a mass—as from the Leonides—meeting the earth head on, as it were, it would enter our atmosphere with an initial speed of 45 miles a second. If such a mass were of sufficient size to escape anything like complete destruction through burning, its force of impact would be enormous. Whether it could or did produce the effects described is, perhaps, yet an open question.

[a] At the time Mr. Gilbert was making his investigations a chemical analysis was made by W. H. Melville, of the vesicular variety (No. III). This Mr. Gilbert has placed in my hands. It is as follows: SiO_2–89.71; Al_2O_3–1.20; FeO–0.34; CaO–4.22; MgO–0.22; K_2O–0.15; Na_2O–0.24; Co_2–3.25; Ign.–0.74; loss at 100°–0.20. Total, 100.27.

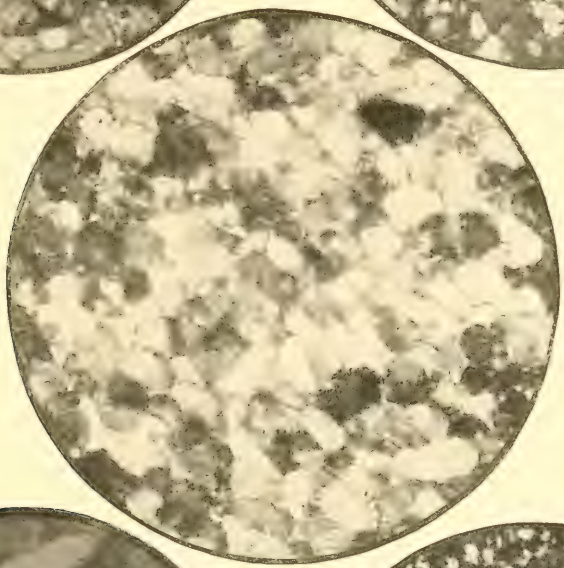
[b] Coon Mountain and its Crater. Proc. Acad. Nat. Sci., Phila. 1905, p. 885.



1

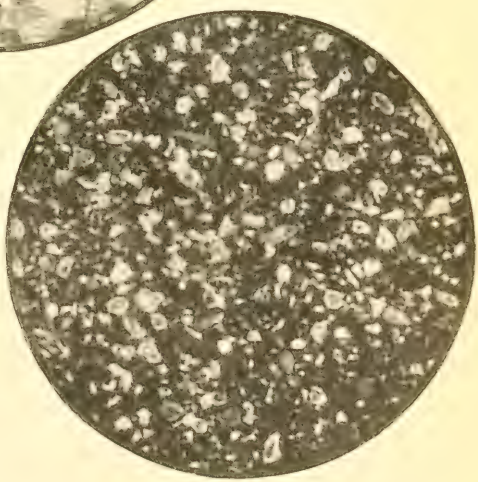


2



5

3



4

MICROSTRUCTURE OF SILICEOUS SANDSTONE.

FOR EXPLANATION SEE TEXT.

A NEW SPECIES OF CRINOID (PTILOCRINUS PINNATUS) FROM THE PACIFIC COAST, WITH A NOTE ON BATHYCRINUS.

By Austin H. Clark,
Of the United States Bureau of Fisheries.

In working over the stalked crinoids obtained by the United States Fisheries steamer *Albatross* in the north Pacific, I find the following interesting form which has never been described. The species is represented by twenty-four calyces, most of them with more or less of the stem attached, fourteen stems and pieces of stems, and a number of detached arms and pinnules. None of the specimens are absolutely perfect, but four are nearly so, having lost only a few pinnules, and in one or two the distal portion of the arms. These specimens were all obtained at station No. 3342, on September 3, 1890, in 52° 39′ 30″ north latitude, 132° 38′ 00″ west longitude, near the coast of Moresby Island, Queen Charlotte group, in a depth of 1,588 fathoms. The bottom was gray ooze and coarse sand, and the bottom temperature 35.3° F. (corrected). This is remarkable in being the only stalked crinoid known from the eastern Pacific, with the exception of the closely related *Calamocrinus diomedæ* A. Agassiz from the Galapagos Islands. I was at first inclined to regard this form as a second species of *Calamocrinus*, but a more careful examination has convinced me that it should be separated generically; and for it, therefore, I propose the generic name of

PTILOCRINUS[a] Clark, new genus.

The characters of the genus are given with those of the type species, *Ptilocrinus pinnatus*.

PTILOCRINUS PINNATUS Clark, new species.

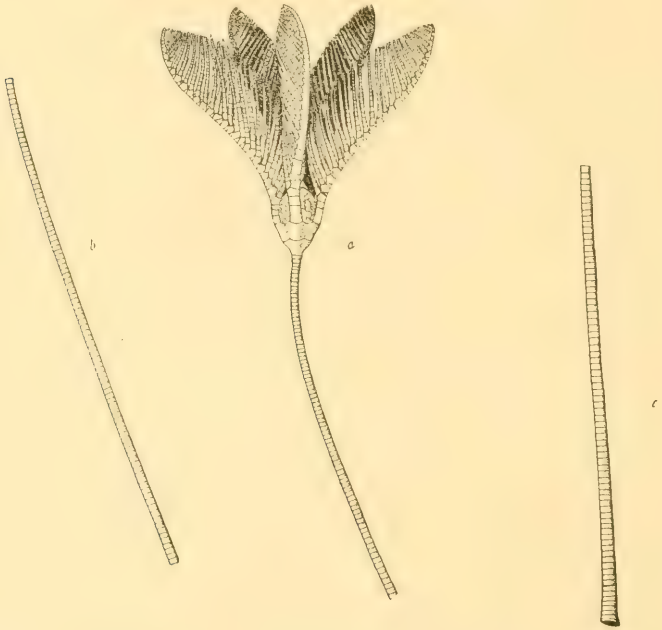
Type.—Cat. No. 22603, U.S.N.M.

Basals completely anchylosed into a funnel-shaped cup as in *Bathycrinus*, about four-fifths the height of the primary radials. The height

[a] πτίλον, feather; κρίνον, lily.

of the basal cup is about equal to its width where it joins the radials, and to twice its diameter at the dorsal pole. (See fig.)

Primary radials closely united, the interradial sutures usually distinct, but in some cases nearly obsolete; basi-radial sutures usually rather more distinct than the interbasal. The primary radials are elongate, the median part of each one raised into a rounded ridge, giving the calyx a rounded pentagonal aspect when viewed dorsally. About two-thirds of the center of the superior edge of the primary radials is occupied by the first brachials; but the radials are not especially incised for their reception



PTILOCRINUS PINNATUS. *a*, CROWN AND UPPER PART OF STEM. *b*, MIDDLE OF STEM. *c*, LOWER PART OF STEM. ½ NAT. SIZE. SEE ALSO PLATE LIII FOLLOWING PAGE 556.

The arms are five in number, and are unbranched. They consist of about sixty joints, with pinnules on (in most cases the left of) the third and all succeeding. The first brachial is usually a syzygy, as are the fourth and sixth, with another after about ten joints, and two or three at irregular intervals toward the tip of the arm. The longest pinnules are between the twentieth and twenty-fifth, these having about thirty joints. The pinnules decrease gradually in length toward the calyx, the first having about twenty joints; distally the decrease in length is rather more rapid, the pinnules at the end of the arms having about ten joints.

The longest stem is 355 mm. in length, and is composed of 360 joints, very uniform in size, but becoming somewhat lower toward the calyx.

and again near the base. The stem is smooth and very slender, all the joints being practically cylindrical; it tapers gradually from the base upward, expanding again slightly near the calyx. There appears to be a rather unusual amount of flexibility in the stem of this species, especially near the calyx, for in some of the specimens it is so much arched that the arms point straight down; on removing them from the alcohol, the stem may be straightened out again without injury.

Interradial plates are present, similar in character to those of *Calamocrinus diomedæ*, but much larger in proportion.

Some of the specimens are parasitized by *Eulima ptilocrinicola* Bartsch, which in one has resulted in a very considerable distortion of the calyx. Another has three holes completely perforating the plates of the calyx, evidently made by this species.

BATHYCRINUS AUSTRALIS Clark, new name.

In 1876[a] Sir C. Wyville Thomson described a new *Bathycrinus* from a single specimen taken by the *Challenger* at Station No. 106, August 25, 1873, in 1° 47′ north latitude, 24° 26′ west longitude, under the name of *Bathycrinus aldrichianus*, illustrating his description with a woodcut of a drawing made on board the *Challenger*. Subsequently about a dozen other specimens of *Bathycrinus* were obtained by the *Challenger*, which were referred by Sir Wyville to this species.

In working up the stalked crinoids of the *Challenger* collection, Dr. P. Herbert Carpenter[b] found that Sir Wyville had united two species under the name of *B. aldrichianus*, not realizing at the time that the single small specimen obtained near the equator was specifically distinct from the larger examples secured in the South Temperate Zone.

Now unfortunately Doctor Carpenter in his great work applied Sir Wyville's name *B. aldrichianus* to the specimens obtained in the South Temperate Zone, being led into error through Sir Wyville's later writings, where he limits the name *B. aldrichianus* to these same examples; and he gives the new specific name *Bathycrinus campbellianus* (Wyville Thomson MSS.) to the single specimen obtained at station No. 106, the very one which eight years before served as the type of *B. aldrichianus*. The woodcut originally used in 1876 to illustrate *B. aldrichianus* was used again in 1878[c] to illustrate the same species; but Doctor Carpenter in 1884 used the same woodcut to represent his *B. campbellianus*. It is clear, then, that the names *B. aldrichianus* and *B. campbellianus* are synonyms, being founded on the same specimen, and also that the name *B. aldrichianus* used by

[a] Jour. Linn. Soc. London, Zoology, XIII, p. 50, fig. p. 49.

[b] Challenger Reports, Report on the Crinoidea, vol. xi of Zoology, p. 239.

[c] The Atlantic, II, p. 85, fig. 23.

Doctor Carpenter for the southern specimens is wholly inadmissible for them, being based on the specimen referred to (and described) by him as *B. campbellianus*.

I propose, therefore, that the species called by Doctor Carpenter *B. aldrichianus* be known as *Bathycrinus australis*, and that 46° 16′ south latitude, 48° 27′ east longitude, be considered the type-locality.

The species of *Bathycrinus*, then, are as follows:

Genus BATHYCRINUS Wyville Thomson.

1872. *Bathycrinus* Wyville Thomson, Proc. Roy. Soc. Edinb., VII, p. 772.

Type.—*Bathycrinus gracilis* Wyville Thomson.

BATHYCRINUS GRACILIS Wyville Thomson.

1872. *Bathycrinus gracilis* Wyville Thomson, Proc. Roy. Soc. Edinb., VII, p. 772.

Type-locality. 47° 38′ north latitude, 12° 18′ west longitude; H. M. S. *Porcupine*.

BATHYCRINUS CARPENTERII (Danielssen and Koren).

1877. *Ilycrinus carpenterii* Danielssen and Koren, Nyt Magasin for Naturvidenskaberne, XXIII, 3die Hefte, p. 45.

Type-locality.—63° 22′ north latitude, 1° 20′ east longitude; 65° 55′ north latitude, 7° 20′ east longitude; or 65° 15′ north latitude, 0° 36′ west longitude; Norske Nordhavsexpedition.

BATHYCRINUS ALDRICHIANUS Wyville Thomson.

1876. *Bathycrinus aldrichianus* Wyville Thomson, Jour. Linn. Soc., XIII, p. 50, fig. p. 49. (= *B. campbellianus* of Carpenter.)

Type-locality.—1° 47′ north latitude, 24° 26′ west longitude; H. M. S. *Challenger*.

BATHYCRINUS AUSTRALIS A. H. Clark.

Bathycrinus aldrichianus P. H. Carpenter (not of Wyville Thomson).

Type-locality.—46° 16′ south latitude, 48° 27′ east longitude; H. M. S. *Challenger*.

BATHYCRINUS PACIFICUS A. H. Clark.

1907. *Bathycrinus pacificus* A. H. Clark, Proc. U. S. Nat. Mus., XXXII, p. 510, fig 2.

Type-locality.—33° 18′ 10″ north latitude, 135° 40′ 50″ east longitude; U. S. Bureau of Fisheries Steamer *Albatross*.

A NEW PARASITIC MOLLUSK OF THE GENUS EULIMA.

By Paul Bartsch,

Assistant Curator, Division of Mollusks, U. S. National Museum.

Mr. Austin H. Clark recently called my attention to a *Eulima* found parasitic upon a deep-sea crinoid (*Ptilocrinus pinnatus* Clark). The specimens were dredged by the U. S. Bureau of Fisheries steamer *Albatross* at Station 3342, in 1,588 fathoms, off British Columbia.

These specimens are remarkable for a number of reasons; they represent a truly parasitic species, a fact I believe not heretofore noted in this genus. All three of the individuals found had the proboscis deeply inserted in the side of the body of the crinoid, and it was necessary to sever it in order to release the shell. Some of the crinoids show a number of punctures, probably all made by the *Eulima*.

The parasitic habit, the texture, and weak malleations of the surface recall certain forms of *Stylifer*, but the absence of the mucronate apex and the presence of the operculum place it in *Eulima*.

EULIMA PTILOCRINICOLA, new species.

Shell elongate-conic, thin, polished, transparent, tinged with bluish-white (the dried animal showing through the upper whorls as a granular golden-yellow mass). Whorls eleven, increasing regularly in size, decidedly rounded, with the surface weakly malleated, having a few feebly developed varices which appear at irregular intervals as narrow opaque vertical bands. Summit of the whorls closely appressed to the preceding turn, the extreme edge forming a slender spiral sutural band. Last whorl quite strongly inflated basally. Periphery and base well rounded, marked like the spire. Aperture moderately large, suboval; outer lip thin, evenly curved; columella slender, vertical, slightly reflected; parietal wall covered by a thin callus. Operculum thin, corneous.

The type, Cat. No. 195373, U.S.N.M., measures: Length 9.5 mm., diameter 3.9 mm.

This species differs from all the other West American *Eulimas* of the same size by its rounded whorls and malleated surface.

The three figures on Plate LIII of *Pilocrinus pinnatus* Clark show the *Eulimas* as found, enlarged 1½ diameters. The separate figures of the *Eulimas* are enlarged about 6 diameters, the largest one being the type.

A NEW PARISITIC MOLLUSK.

FOR EXPLANATION OF PLATE SEE PAGE 556.

DESCRIPTIONS OF NEW SPECIES OF ORDOVICIAN FOSSILS FROM CHINA.

By Stuart Weller,
Of the University of Chicago, Chicago, Illinois.

The following new species of Ordovician brachiopods and trilobites were collected by the members of the Carnegie Institution Expedition to Eastern Asia in 1903–4. They are all from the Ki-sin-ling limestone at two localities near Su-kia-pa, in the province of Ssï-ch'uan, China. Locality 20 C is in a gulch just northeast of Su-kia-pa, while locality 20 B is at the narrows of the Ta-ning River 1½ miles above the same place. The formation from which the fossils were secured is a dark, massive limestone 3,500 feet in thickness lying comformably upon subjacent beds of Cambrian age. The fossils are all from the uppermost layers of the formation, and in age are approximately equivalent to the fauna of the Trenton limestone of North America.

The types of the new species here described will be deposited in the United States National Museum on the completion of the forthcoming report of the Expedition to be published by the Carnegie Institution, in which work also illustrations of all the species will appear.

Order BRACHIOPODA.

PLECTORTHIS WILLISI, new species.

Description.—Shell transversely subelliptical in outline, the hinge line a little shorter than the greatest width, cardinal extremities slightly rounded. Pedicle valve depressed-convex, slightly compressed toward the cardinal extremities; the beak small, scarcely incurved, cardinal area a little concave, sloping backward from the plane of the valve; cardinal margins angular. Brachial valve nearly as convex as the pedicle, compressed toward the cardinal extremities. Surface of each valve marked by from twenty to twenty-five major, radiating, rounded costæ, which increase in width conspicuously in passing from the beak to the front margin; in each interspace between these major costæ from one to three smaller ones which do not reach

the beak are intercalated. The more minute surface markings are destroyed.

The dimensions of a pedicle valve are: Length, 7.5 mm.; width, 12 mm.; height of area, 1 mm.; convexity, 2 mm.

Remarks.—The most notable feature of this shell is the conspicuous broadening of the major costæ in passing from the beak to the front margin.

The specific name is in honor of Mr. Bailey Willis, the leader of the Carnegie Expedition to China.

Formation and Locality.—Ki-sin-ling limestone, localities 20 C and 20 B, near Su-kia-pa, province of Ssï-ch'uan.

CLITAMBONITES CHINENSIS, new species.

Description.—Shell broader than long, the hinge line straight, the greatest width at the hinge line or a little in front of it, the lateral and anterior margins describing a regular curve. Pedicle valve strongly elevated at the beak, the surface sloping from the umbo to the anterior and antero-lateral margins with a slightly convex curve, sometimes becoming a little concave as it approaches the anterior margin, the slope to the cardinal extremities somewhat more abrupt; cardinal area large, flat, sloping posteriorly from the hinge line in one specimen at an angle of 102° and in another at an angle of 115° to the plane of the valve, the cardinal margins sharp; delthyrium rather narrow, closed with a strongly convex deltidium, foramen terminal, encroaching upon the umbo; median septum inconspicuous; muscular impressions indefinite, rather large and flabelliform. Surface of each valve marked by fine radiating costæ, two or three of which occupy the space of one millimeter.

The dimensions of two pedicle valves are: Length, 15 mm. and 14 mm.; width, 18.7 mm. and 16.9 mm.; height of cardinal area, 5 mm. and 5 mm.; greatest width of deltidium, 3 mm. and 2.5 mm. The dimensions of a brachial valve are: Length, 16.5 mm.; width, 21 mm.; convexity, 4 mm.

Remarks.—This species is represented in the collection by only a small number of specimens, none of which are as well preserved as might be desired. It differs especially from other members of the genus in the terminal position of the pedicle opening, the pedicle apparently having passed through the foramen in a direction continuous with the surface of the deltidium and not at an angle to it, as is usually the case. Apparently this position of the pedicle also modified the position of the spondylium, its surface being nearly vertical to the inner surface of the valve, in consequence of which the median septum becomes essentially obsolete.

Formation and locality.—Ki-sin-ling limestone, localities 20 C and 20 B, near Su-kia-pa, province of Ssï-ch'uan.

HEMIPRONITES TENUISTRIATA, new species.

Description.—Shell wider than long, the valves subequally convex, the hinge line a little shorter than the greatest width, the cardinal extremities subangular. Pedicle valve most prominent on the umbo, the beak rather obtuse, the surface sloping from the umbo laterally and anteriorly with a gently convex curve; a slight, scarcely noticeable mesial flattening of the valve occurs toward the front, but no mesial sinus is present; cardinal area flat, rather large, with a broad deltidium, the cardinal margins angular. Brachial valve most prominent along the median line, but with no differentiated median fold, the greatest convexity at about the mid-length of the valve, the surface slightly compressed toward the cardinal extremities. Surface of each valve marked by exceedingly fine striæ, which are scarcely visible to the naked eye, about eight occupying the space of one millimeter.

The dimensions of a pedicle valve are: Length, 16 mm.; width, approximately 17.5 mm.; convexity, 5 mm.; height of cardinal area, 3 mm.; length of hinge line, 15 mm. The dimensions of a brachial valve are: Length, 17 mm.; width, 22 mm.; convexity, 5 mm.

Remarks.—The specimens of this species in the collection are all too poorly preserved to allow the determination of its generic position with entire satisfaction. They have, however, the general form of European members of the genus *Hemipronites*, and it is believed that this generic reference is correct, but the nature of the deltidium and the presence or absence of a foramen can not be certainly determined. The genus *Hemipronites* has not been recognized in the American faunas, and is known especially from the Baltic provinces in Russia. The species is evidently congeneric with the shell which Martelli has called *Orthisina giraldi*[a] and the two species are closely allied. The species here described, however, is somewhat more finely striate, and it seems to be relatively a somewhat broader shell.

Formation and locality.—Ki-sin-ling limestone, locality 20 C, near Su-kia-pa, province of Ssï-ch'uan.

Order TRILOBITA.

AMPYX CHINENSIS, new species.

Description.—Cranidium subsemicircular in outline, width 6.8 mm., length 3.5 mm. Glabella prominent, produced anteriorly somewhat beyond the frontal margin, subangular along the dorsal median line, the sides convex and sloping rather abruptly to the dorsal furrows; at the anterior termination of the glabella is the fractured base of a slender cylindrical spine whose length can not be determined, lateral furrows obsolete. Occipital furrow narrow and shallow. Occipital

[a] Boll. della Soc. Geol. Ital., XX (1901), p. 305.

segment very short. The fixed cheeks are broad, convex, and subtriangular in outline, marked by post-marginal furrows, which continue from the extremities of the occipital furrow.

Remarks.—This species is a close ally of *A. nasutus* Dalman, but it differs from all illustrations of that species in its proportionally greater width. The thorax and pygidium have not been observed, the species being founded upon a single nearly perfect cranidium.

Formation and locality.—Ki-sin-ling limestone, locality 29 C, near Si-kia-pa, province of Ssï-ch'uan.

ASAPHUS BLACKWELDERI, new species.

Description.—Cranidium comparatively short and broad with the axis obsolete, obtusely angular in front, the palpebral lobes large and prominent, their anterior margins nearly opposite the middle point of the head; in front of the eyes the lateral margins diverge gradually to a point nearly halfway to the anterior margin, where they are rather broadly rounded, and then converge somewhat abruptly to the anterior extremity; back of the eyes the lateral margins diverge rapidly and curve backward to the posterior margin, the width of the cranidium along its posterior margin being considerably greater than the distance between the eyes. The occipital furrow and segment faintly developed. A slight median tubercle is situated at a point about halfway between the line joining the posterior extremities of the eyes and the posterior margin, aside from which the surface of the cranidium is apparently smooth.

A free cheek is associated with this cranidium and possibly belongs to the same species; its lateral region is differentiated as a rounded marginal border, and its genal angle is produced into a rather strong genal spine.

The dimensions of the cranidium described are: Length, 8 mm.; width between the eyes, 6 mm.; width along posterior margin, 7.5 mm.

Remarks.—The outline of the cranidium upon which this species is established somewhat closely resembles that of *A. expansus* Dalman, the typical species of the genus, and both species are marked by a similar small median tubercle near the posterior margin. This Chinese species may be distinguished from its European ally, however, on account of the obsolete glabella. If the free cheek which occurs with *A. blackwelderi* really belongs to the species, this also will serve to distinguish the two forms by reason of its strongly developed genal spine, these spines being absent from the European species.

This new species is named in honor of Mr. Eliot Blackwelder, who collected the type specimens.

Formation and locality.—Ki-sin-ling limestone, locality 20 B, near Si-kia-pa, province of Ssï-ch'uan.

ASAPHUS TANINGENSIS, new species.

Description.—Cranidium rather long and slender, with the axis nearly obsolete; the palpebral lobes apparently rather small, situated back of the mid-length of the head. In front of the eyes the lateral margins of the cranidium describe the two sides of an ovate curve, gently diverging from the anterior extremities of the eyes, then broadly rounding and converging abruptly in front to the obtusely subangular anterior extremity; back of the eyes the lateral margins diverge abruptly with a gently convex curve to the posterior margin. Anteriorly the surface of cranidium is somewhat flattened to form an indistinct anterior limb. Occipital furrow and segment nearly obsolete. A faint median tubercle is situated on the median line of the head about halfway between the line joining the posterior extremities of the eyes and the posterior margin, but aside from this the surface of the cranidium is smooth.

The dimensions of the type specimen are: Length of cranidium, 11 mm.; width at posterior margin, 11.5 mm.; width between the eyes, 7 mm.

Remarks.—This species is known only from the cranidium and it is of course possible that it should be correlated with some one of the species here described from the pygidium alone. The only one of these pygidia, however, which is recognized from exactly the same locality as this species, is *A. lævis*, which is such a short form that it is not at all likely to be a portion of the same species as this elongate cranidium. The species should perhaps be referred to the genus *Megalaspis* rather than *Asaphus*, but this can not be determined from such incomplete material.

Formation and locality.—Ki-sin-ling limestone, locality 20 B, near Su-kia-pa, province of Ssï-ch'uan.

ASAPHUS ASIATICUS, new species.

Description.—Pygidium subsemielliptical in outline, moderately convex, the axis depressed, bordered by rather broadly rounded axial furrows which become obsolete posteriorly; plural slopes prominent just outside the axial furrows, then sloping with a convex surface to the margins, without a differentiated marginal border. Axis occupying about one-third the total width of the pygidium anteriorly, tapering posteriorly to a bluntly rounded point, divided by rather broad and shallow, obscure furrows into twelve segments. Pleural slopes divided into about twelve obscure segments which reach less than half way from the axial furrows to the margins, the most anterior furrow crossing the plural slope is broad and deep, being much more conspicuous than those behind

The dimensions of the type specimen, an incomplete pygidium, are: Length, 20.5 mm.; width, about 30 mm.; width of axis anteriorly, 10 mm.; length of axis, 16 mm.

Remarks.—This species is known only from the pygidium which is much like that of the European *A. expansus*, being distinguished chiefly by its greater proportional length and by the more obscure segmentation.

Formation and locality.—Ki-sin-ling limestone, locality 20 C, near Su-kia-pa, province of Ssï-ch'uan.

ASAPHUS LÆVIS, new species.

Description.—Pygidium nearly semicircular in outline. The axis depressed, without segmentation, poorly defined by the nearly obsolete axial furrows, occupying about one-fourth of the total width of the pygidium anteriorly; pleural slopes smooth, without segmentation, convex toward the axis but becoming depressed in a broad, moderately concave marginal border toward the outer margin. The posterior extremity of the axis reaching the inner margin of the concave border.

The dimensions of the type specimen are: Length, 12 mm.; width, 23 mm.; width of axis anteriorly, 5.5 mm.; length of axis, 8.5 mm.; width of concave marginal border, about 3.5 mm.

Remarks.—This species is represented in the collection by a single nearly complete pygidium. So far as can be determined, it seems to be a member of the genus *Asaphus* in its strict sense, the species being especially characterized by its remarkably smooth surface.

Formation and locality.—Ki-sin-ling limestone, locality 20 B, near Su-kia-pa, province of Ssï-ch'uan.

ASAPHUS CHINENSIS, new species.

Description.—This species is founded upon a single nearly perfect pygidium and is much like the last-described form. It differs in its proportions, however, its dimensions being: Length, 14 mm.; width, 22.5 mm.; width of axis anteriorly, 6.8 mm.; length of axis, 9.5 mm.; width of concave marginal border, about 4 mm. The most marked differences between the two species is the much more conspicuous concave border in *A. chinensis* and in the slight though obscure traces of segmentation upon both the axis and the pleural slopes. This latter character, however, may be due to the removal of the test from the central portion of the specimen, and if the external surface were preserved it might be as smooth as *A. lævis*.

Formation and locality.—Ki-sin-ling limestone, locality 20 C, near Su-kia-pa, province of Ssï-ch'uan.

MEGALASPIS MINOR, new species.

Description. – Pygidium small, subelliptical in outline. Axis scarcely elevated above the general surface, about one-third of the total width of the pygidium anteriorly, tapering to the rather bluntly rounded posterior extremity, divided by nearly obsolete depressions into eight or nine obscure segments. Pleural slopes regularly convex from the sides of the axis to the margins, without a differentiated marginal border, marked by about six narrow, faint, grooved segments which reach halfway across the slopes. Anteriorly, close to the margin and parallel with it a subangular groove extends from each side of the axis about halfway across the pleural slopes; in front of and outside the lateral extremities of these grooves the surface is abruptly compressed.

The dimensions of the type specimen are: Approximate length, 9 mm.; width, 14.5 mm.; width of axis anteriorly, 4.8 mm.; length of axis, 7 mm.

Remarks. –This species is known only from the pygidium, and even that portion is incomplete. It is referred to the genus *Megalaspis* by reason of the grooved pleural segments. The segmentation is very faint and would probably be even less distinct or perhaps obsolete entirely were the test of the specimen preserved.

Formation and locality. –Ki-sin-ling limestone, locality 20 B, near Su-kia-pa, province of Ssï-ch'uan.

ILLÆNUS? BRONTEOIDES, new species.

Description.—Pygidium subsemicircular in outline, flattened on top. Axis ill defined, unsegmented, occupying a little less than one-third the total width of the pygidium anteriorly, very slightly elevated in front and merging into the general surface of the pygidium posteriorly. Pleural slopes flattened on each side of the axis, sloping to the margins exteriorly with a slightly concave curve. The surface of each pleural slope, when the test is removed, is marked by about twelve or thirteen very narrow and scarcely elevated ribs, which are grooved longitudinally and extend from the indefinite axial furrows about to the line where the surface begins its more abrupt slope to the lateral margins.

The dimensions of the type-specimen are: Length, 8.5 mm.; width, 14.8 mm.; width of axis anteriorly, 4.5 mm.

Remarks.—This species is represented by a single specimen in the collection, a nearly complete pygidium. It is a peculiar form, having the general contour of an *Illænus*, but with the pleural slopes faintly segmented, suggesting the genus *Bronteus*. These segments are very faint, however, and would possibly not be visible at all were the specimens completely covered with the test.

Formation and locality.—Ki-sin-ling limestone, locality 20 C, near Su-kia-pa, province of Ssï-ch'uan.

DESCRIPTIONS OF NEW SPECIES OF MOTHS OF THE FAMILY COCHLIDIIDÆ.

By Harrison G. Dyar,
Assistant Curator, Division of Insects, United States National Museum.

The following new forms have been recently discovered by Mr. William Schaus during his travels through Mexico.

PARASA CUERNAVACA, new variety.

A form of *P. chloris* Herrich-Schaeffer, in which the green band on the fore wings is much narrower than in specimens from the Atlantic coast of the United States. The specimens agree with *P. minima* Schaus in markings, but are distinctly larger and more robust. These are probably all local forms of *P. chloris*, but this can not be positively stated until the larvæ have been observed. I have described a form from Arizona in which the green band is broader than usual. These forms may be listed as follows:

Parasa chloris Herrich-Schaeffer, eastern United States.
var. *huachuca* Dyar, Huachuca Mountains, Arizona.
var. *cuernavaca* Dyar, Cuernavaca, Mexico.
var. *minima* Schaus, Coatepec and Jalapa, Mexico.
var. (intermediate between *cuernavaca* and *minima*) Costa Rica.

Type.—(of var. *cuernavaca*) Cat. No. 10337, U.S.N.M.

Five males from Cuernavaca, Mexico, June, July, and August, 1906 (W. Schaus).

EUCLEA RETROVERSA, new species.

Fore wing blackish brown, with a pinkish tint along the costa and in a curved streak beyond cell to tornus, cut by a heavy black bar that runs out from the base along the submedian fold to margin; discal dot black, much elongated; a slender nearly straight silvery line subapically from costa to the pinkish band; a subbasal silvery line below cell, with a single outward arc, within which the ground color is pinkish. Hind wings pinkish brown, the fringe touched with dark brown at the anal angle. Thorax, tip of abdomen, and legs dark brown. Expanse, 20 mm.

Three males, Cuernavaca, Mexico, June and July, 1906 (W. Schaus).

Type.—Cat. No. 10338, U.S.N.M.

Allied to *diversa* Druce and *baranda* Schaus, but both of these have rounded discal marks, and the shape of the silvery lines is different.

VIPSANIA ANTICLEA Druce.

Male. Agrees entirely in coloration with the female figured in the Biologia Centrali-Americana, except that the hind wings are pale instead of blackish. There is a marked difference in palpal structure between the sexes. In the female they are nearly porrect, the second joint being long and only very slightly curved; the end joint is stout and thick, square on the tip, thickened by the vestiture. In the single male before me the palpi have the second joint strongly curved, so that they stand upright, the third joint long but with a sharply tapered tip. The palpi are not over twice as long as the head, reaching not far above the vertex, whereas in the female they are three times as long as the head. The hind tibiæ have two pairs of spurs. The antennæ are simple.

This genus was placed by me between *Miresa* and *Epiclea*[a] on the supposition that the male antennæ were pectinated to the tip. This proves to have been an erroneous assumption, the genus properly falling between *Vipsophobetron* and *Pseudovipsania*. It differs generically from the latter in having the middle spurs of the hind tibiæ present, and falls in the table with *Lithacodes*, from which it may be separated by the wing shape, sunken head, and palpal structure.

There is a possibility that this is not the male of *Vipsania anticlea* Druce, in which case it is a new species, but the markings and coloration are so exactly alike that I think the association is warranted, in spite of the different palpal structure in the two sexes. The single specimen is from Cuernavaca, Mexico.

EUPROSTERNA COCHLIDIONIS, new species.

Brownish ocherous, the fore wings sprinkled with brownish atoms; basal half darker brownish; a narrow dusky blackish line starts on costa at apical fourth, runs obliquely inward to submedian vein, runs along that vein halfway to base, and is then continued straight to inner margin at basal third; another line starts from the costa at the same, or nearly the same, point and runs obliquely to the outer margin above tornus. Hind wings pale brownish straw color. Expanse, 17 to 19 mm.

Two males, Cuernavaca, Mexico and Iguala, Guerrero, Mexico, June, 1906 (W. Schaus).

[a] Proc. U. S. Nat. Mus., XXIX, 1905, p. 372.

Type.—Cat. No. 10339, U.S.N.M.

The species with its straw-colored wings and diverging brown lines suggests a species of *Cochlidion*.

PLATYPROSTERNA CERES Druce.

Mr. Schaus captured four males in good condition at Iguala, Guerrero, Mexico, altitude 2,400 feet, in June, 1906.

PEROLA CLARA, new species.

Brownish ocherous, the hind wings with an orange tint. On the fore wings are faint red-brown radial streaks on the discal and submedian veins; a red-brown line from costa just before apex gradually curves more and more inward, reaching the inner margin a little before middle. Expanse, 26 mm.

One male, Salina Cruz, Oaxaca, Mexico, September, 1906 (W. Schaus).

Type.—Cat. No. 10340, U.S.N.M.

This species has almost exactly the same markings as *P. druceoides* Dognin, from Ecuador, but is a much smaller species. The dark line on the forewings, too, is slenderer and curves inward in a different manner.

PROLIMACODES DIVIDUA, new species.

Head and thorax dark brown, abdomen concolorous with the hind wings. Fore wings chocolate brown on the costal half, pale brown on the inner half, the two colors separated by a line that begins at the base near costa, runs parallel with it for nearly one-third its length, then curves down nearly to the submedian vein, runs along near this for another third, then goes obliquely, crenulated on the veins, to the apex; basal incision of the brown above submedian vein filled with silvery white, which runs out along the division of the colors to apex, diffused on the lower side; a broad patch of dark color along the inner margin, diminishing toward the tornus. Hind wings pale chocolate brown. Expanse, 27 to 30 mm.

Two males, Cuernavaca, Mexico, June and August, 1906 (W. Schaus).

Type.—Cat. No. 10341, U.S.N.M.

Of the North American species this comes nearest to *P. scapha* Harris. I had at first thought it a variety of this, but the serrations of the antennæ are longer and the brown costal area is differently outlined. A female before me, from Rinconada, Vera Cruz, Mexico, probably belongs here, but the costal area is more rounded, as in *scapha*. It differs therefrom in the greater size of this patch, its crenulate outer edge and the pale area along the inner and outer margins being strewn with dark scales.

ON A COLLECTION OF CRINOIDS OF THE GENUS EUDIOCRINUS FROM JAPAN, WITH DESCRIPTION OF A NEW SPECIES.

By Austin H. Clark,
Of the United States Bureau of Fisheries.

The collections brought back by the United States Fisheries steamer *Albatross* from Japan contained, among many other interesting forms, 320 comatulids belonging to the genus *Eudiocrinus*, which, with three others in the United States National Museum, also obtained in Japan, form the basis of the present paper.

Eudiocrinus was found in abundance along the entire southern shore of Japan, from southern Kiusiu and the Linschoten Islands to the Gulf of Tokio, in water varying from 103 to 712 fathoms, with a bottom temperature of from 37.5° to 56.0° F. Only two species are represented in the 1906 collection, but the specimens in the National Museum taken in 1896 prove to belong to a third species which we did not meet with.

EUDIOCRINUS VARIANS P. H. Carpenter.

There were collected 238 specimens from the following localities:

Station No. 4906.—31° 39′ 00″ north latitude, 129° 20′ 30″ east longitude, Tsurikake Saki Light bearing south 85° east, 17.2 miles distant. Depth, 369 to 406 fathoms; bottom temperature, 43.4° F.; no bottom specimen. August 11, 1906.

One small specimen.

Station No. 4911.—31° 38′ 30″ north latitude, 129° 19′ 00″ east longitude, Tsurikake Saki Light bearing south 88° east, 18 miles distant. Depth, 391 fathoms; bottom temperature, 41.9° F.; bottom, gray globigerina ooze. August 12, 1906.

Four rather small specimens.

Station No. 4912.—31° 39′ 40″ north latitude, 129° 20′ 00″ east longitude, Tsurikake Saki Light bearing south 84° east 17.5 miles distant. Depth, 391 fathoms; bottom temperature, 41.9° F.; bottom, gray globigerina ooze. August 12, 1906.

Thirteen medium-sized specimens.

Station No. 4915.—31° 31′ 00″ north latitude, 129° 25′ 30″ east longitude, Tsurikake Saki Light bearing north 62° east, 14.8 miles distant. Depth, 427 fathoms; bottom temperature, 41.9° F.; bottom, gray globigerina ooze and broken shell. August 12, 1906.

One small specimen.

Station No. 4916.—30° 25′ 00″ north latitude, 129° 06′ 40″ east longitude, Gwaja Shima bearing south 37° east, 37.5 miles distant. Depth, 361 fathoms; bottom temperature, 42.7° F.; bottom, gray sand, globerina ooze, and broken shell. August 13, 1906.

Three medium-sized specimens.

Station No. 4919.—30° 34′ 00″ north latitude, 129° 22′ 00″ east longitude, Kusakaki Jima bearing north 10° east, 17.5 miles distant. Depth, 440 fathoms; bottom temperature, 41.8° F.; bottom, globigerina ooze. August 13, 1906.

One hundred and four medium-sized specimens.

Station No. 4920.—30° 34′ 00″ north latitude, 129° 22′ 00″ east longitude, Kusakaki Jima bearing north 10° east, 17.5 miles distant. Depth, 440 fathoms; bottom temperature, 41.8° F.; bottom, globigerina ooze. August 13, 1906.

Five specimens.

Station No. 4975.—33° 21′ 30″ north latitude, 135° 38′ 50″ east longitude, Shio Misaki Light bearing north 49° east, 7 miles distant. Depth, 712 fathoms; bottom temperature, 37.5° F.; bottom, brown mud, pebbles, and foraminifera. August 31, 1906.

Nine medium-sized specimens.

Station No. 5082.—34° 05′ 00″ north latitude, 137° 59′ 00″ east longitude, Omai Saki Light bearing north 22° east, 33 miles distant. Depth, 662 fathoms; bottom temperature, 37.7° F.; bottom, green mud, fine sand, globigerina ooze. October 20, 1906.

Seventy medium-sized specimens.

Station No. 5083.—34° 04′ 20″ north latitude, 137° 57′ 30″ east longitude, Omai Saki Light bearing north 23½° east, 34.5 miles distant. Depth, 624 fathoms; bottom temperature, 38.1° F.; bottom, fine gray sand and globigerina ooze. October 20, 1906.

Twenty-eight large specimens.

This species was obtained at depths varying from 361 to 712 fathoms and at temperatures of from 37.5° to 43.4° F., the average depth being 483.6 fathoms and the mean temperature being 40.8° F. The specimens from Station No. 5083 were the largest, measuring: arms, 106 mm.; longest cirri, 50 mm. There is considerable variation in this species in regard to the extent of the first brachials beyond the centrodorsal. In most of the examples the first brachials are fairly conspicuous, but in one or two they do not show at all, so that the first pinnule is borne on the lowest visible arm joint. The arms and cirri are long

and slender, the centro-dorsal comparatively small, giving this species a remarkably attenuated appearance. The color in life is a dull purplish brown, the skeleton and cirri nearly white, the disc black.

EUDIOCRINUS JAPONICUS P. H. Carpenter.

There were collected 82 specimens from the following localities:

Station No. 4900.—32° 28′ 50″ north latitude, 128° 34′ 40″ east longitude, Ose Saki Light bearing north 83° east, 14.5 miles distant. Depth, 207 fathoms; bottom temperature, 52.9° F.; bottom, fine gray sand and broken shell. August 10, 1906.

Four small specimens.

Station No. 4903.—32° 31′ 10″ north latitude, 128° 33′ 20″ east longitude, Ose Saki Light bearing north 22° east, 6 miles distant. Depth, 139 to 107 fathoms; bottom temperature, 52.9° F.; bottom, gray sand and broken shell. August 10, 1906.

Two medium-sized specimens.

Station No. 4916.—One medium-sized specimen.

Station No. 4919.—Two specimens.

Station No. 4934.—30° 58′ 30″ north latitude, 130° 32′ 00″ east longitude, Sata Misaki Light bearing north 77½° east, 7 miles distant. Depth, 152 to 103 fathoms; bottom temperature, 56.0° F.; bottom, rocky. August 16, 1906.

Thirteen medium-sized specimens.

Station No. 4958.—32° 36′ 20″ north latitude, 132° 24′ 30″ east longitude, Mizimoko Shima Light bearing north 26° west, 29.3 miles distant. Depth, 405 fathoms; bottom temperature, 40.1° F.; bottom, green and brown mud, fine gray sand, and foraminifera. August 23, 1906.

Eleven large specimens.

Station No. 4975.—Two medium-sized specimens.

Station No. 4976.—33° 22′ 50″ north latitude, 135° 38′ 30″ east longitude, Shio Misaki Light bearing north 59° east, 6.4 miles distant. Depth, 545 fathoms; bottom temperature, 38.7° F.; bottom, brown mud and small stones. August 31, 1906.

Three medium-sized specimens.

Station No. 4980.—34° 09′ 00″ north latitude, 137° 55′ 00″ east longitude. Depth, 507 fathoms; bottom temperature, 39° F.; bottom, brown mud, fine sand, and foraminifera. September 1, 1906.

Twenty-five medium-sized specimens.

Station No. 5079.—34° 15′ 00″ north latitude, 138° 00′ 00″ east longitude, Omai Saki Light bearing north 29° east, 24 miles distant. Depth, 475 fathoms; bottom temperature, 39.1° F.; bottom, pebbles. October 19, 1906.

Two medium-sized specimens.

Station No. 5082.—Two medium-sized specimens.

Station No. 5083.—Fifteen large specimens.

Eudiocrinus japonicus was found at depths of from 103 to 712 fathoms (mean 388 fathoms) with bottom temperatures ranging from 37.5° to 56.0° F., the mean being 43.5° F. The largest specimens (arm 125 mm., longest cirri 54 mm.) are from station No. 4958, where *E. varians* was not found; but examples from station No. 5083 are nearly as large (arm 100 mm., longest cirri 42 mm.), and were associated with large individuals of the other species.

The two species were found associated at the following stations:

Station number.	Depth.	Bottom temperature.
	Fathoms.	° *F.*
4916	361	42.7
4919	440	41.8
4975	712	37.5
5082	662	37.7
5083	624	38.1

E. varians only was found at—

Station number.	Depth.	Bottom temperature.
	Fathoms.	° *F.*
4906	369–406	43.4
4911	391	41.9
4912	391	41.9
4915	427	41.9
4920	440	41.8

E. japonicus only was found at—

Station number.	Depth.	Bottom temperature.
	Fathoms.	° *F.*
4900	207	52.9
4903	139–107	52.9
4934	152–103	56.0
4958	405	40.1
4976	545	38.7
4980	507	39.0
5079	475	39.1

The type of *E. varians* was obtained in 16° 42′ north latitude, 119° 22′ east longitude, in 1,050 fathoms, and that of *E. japonicus* in 34° 7′ north latitude, 138° 0′ east longitude, in 565 fathoms, the temperature in the case of the former being 37° and in the case of the latter 38.1°; while the natural inference would be that *E. varians* was an abyssal form inhabiting very cold water and *E. japonicus* a comparatively shallow-water form, the data here given suggests that in reality both

have about the same habitat so far as temperature and depth are concerned, although it is worthy of note that at the stations with the least depth and highest temperatures *E. japonicus* alone was found. Another interesting fact is that at the stations where both species occurred together the examples of each were of practically the same size; where *E. varians* was large and robust *E. japonicus* was also large and robust, and, conversely, where *E. varians* was small *E. japonicus* was also small, thus suggesting that the same factors influenced the growth of each in the same degree.

Eudiocrinus japonicus can be distinguished at a glance from *E. varians* by its more robust and massive appearance. In color the two species are practically the same.

EUDIOCRINUS TUBERCULATUS Clark, new species.

In general similar to *E. japonicus*, but even more robust, with the junctions of the first eight or ten brachials strongly tubercular. The tubercle between the first two is in the median line; those on the following joints lie alternately on either side of the arm.

The greatest difference between this species and *E. japonicus* is in the character of the cirri; in *E. tuberculatus* they are but 18 mm. in length consisting of about 17 joints, although the specimens are rather larger than any of my *E. japonicus*, in the largest of which the cirri reach 54 mm. in length.

Station No. 3661.—Off Uki Shima, Gulf of Tokyo, 169 fathoms; bottom temperature, 48° F.; bottom, mud and pebbles. October 13, 1896.

Type.—Cat. No. 22604 U.S.N.M. from this station.

Three specimens.

The following is a list of the known recent species of *Eudiocrinus*:

EUDIOCRINUS P. H. Carpenter.

1882. *Eudiocrinus* P. H. Carpenter, Jour. Linn. Soc. (Zool.), XVI, p. 493 (first mentioned p. 488); new name for *Ophiocrinus* Semper, preoccupied.

Type.— *Ophiocrinus indivisus* Semper.

EUDIOCRINUS ATLANTICUS Perrier.

1883. *Eudiocrinus atlanticus* Perrier, Comptes Rendus, XCVI, p. 725.

Type-locality.—Gulf of Gascony, 896 meters. French steamship *Travailleur*.

EUDIOCRINUS GRANULATUS Bell.

1894. *Eudiocrinus granulatus* Bell, Proc. Zool. Soc., 1894, p. 397, pl. xxiii (first mentioned p. 396).

Type-locality.—Macclesfield Bank, west of Luzon, Philippine Islands; 34–40 fathoms. H. M. S. *Egeria*.

EUDIOCRINUS INDIVISUS (Semper).

1868. *Ophiocrinus indivisus* SEMPER, Archiv für Naturgesch., Jahrg. 34, Bd. 1, p. 68.

Type-locality.—Pandanon, near Bohol, Philippine Islands; 30 fathoms. Prof. C. Semper.

EUDIOCRINUS JAPONICUS P. H. Carpenter.

1882. *Eudiocrinus japonicus* P. H. CARPENTER, Jour. Linn. Soc. (Zool.), XVI, p. 495; detailed description on p. 499.

Type-locality.—34° 7′ north latitude, 138° 0′ east longitude off the south coast of Nipon; 565 fathoms. H. M. S. *Challenger.*

EUDIOCRINUS SEMPERI P. H. Carpenter.

1882. *Eudiocrinus semperi* P. H. CARPENTER, Jour. Linn. Soc. (Zool.), XVI, p. 495; detailed description p. 497.

Type-locality.—34° 8′ south latitude, 152° 0′ east longitude, near Sydney, New South Wales; 950 fathoms (figured specimen). H. M. S. *Challenger.*

EUDIOCRINUS TUBERCULATUS A. H. Clark.

Type-locality.—Off Uki Shima, Gulf of Tokyo; 169 fathoms. U. S. S. *Albatross.*

EUDIOCRINUS VARIANS P. H. Carpenter.

1882. *Eudiocrinus varians* P. H. CARPENTER, Jour. Linn. Soc. (Zool.) XVI, p. 495; detailed description p. 496; first mentioned p. 494.

Type-locality.—16° 42′ north latitude, 119° 22′ east longitude, off the west coast of Luzon, Philippine Islands, 1,050 fathoms. H. M. S. *Challenger.*

NOTES ON THE PORCUPINES OF THE MALAY PENINSULA AND ARCHIPELAGO.

By Marcus Ward Lyon, Jr.,

Assistant Curator, Division Mammals, U. S. National Museum

The following notes are of a preliminary nature only, and are written with the idea of bringing together in one place a consideration of the systematic names of the Malayan porcupines and the characters by which these animals are arranged into natural groups, both of which considerations are at present scattered through various publications. The main features brought out in this paper are the division of the Old World porcupines into two subfamilies; the revival of Cuvier's name *Acanthion* as a genus for the short-tailed Malayan porcupines; the revival of Linnæus's name *Hystrix brachyura* as the proper specific designation of the short-tailed porcupine of the Malay Peninsula; the description of a new genus and species of short-tailed porcupine collected in northern Sumatra by Dr. W. L. Abbott in 1906; and the description of a new species of *Atherurus* from Pulo Terutau, off the west coast of the Malay Peninsula. The presence of two distinct genera of long-tailed porcupines in the Malayan region caused considerable confusion in the use of names by the older writers, but Jentink,[a] in 1894, clearly pointed out the true status of these groups. Seba was well acquainted with three of the four genera of Old World porcupines that have been recognized up to the present time, and it was largely from his descriptions and plates that Linnæus in the tenth edition of the Systema Naturae based three names of the Old World porcupines, which at that time were regarded as so many distinct species and not as distinct generic types as they have since been considered.

It is to regretted that more examples of the typical genus *Hystrix* have not been available in the preparation of these notes for determining the true status of the genus, *Acanthion*, which has usually been

[a] Notes Leyden Museum, XVI, 1894, p. 205.

considered synonymous with part of *Hystrix*. However, the material at hand shows very considerable differences between *Hystrix* proper and *Acanthion*, which will be pointed out further on. With regard to some of the species in the various genera of Malayan porcupines, I have not seen a sufficient number of specimens to determine the characters satisfactorily. Where several forms of one group, each form occupying a definite and isolated geographic area, have been named I have made use of the names bestowed upon them even if their specific characters are not clear, believing this plan better than to place them under one specific name, for material is as lacking to show their identity as it is to show their distinctness.

The list of works to which reference has been made in preparing these notes will be found under the synonymy of the different species or referred to in footnotes. The specimens on which these notes are based are listed in the table of measurements, page 593. They represent forty individuals from Malaya, thirty-three skins with skulls, two odd skulls, and five skeletons. All but three of these specimens were collected by Dr. W. L. Abbott, and have been presented by him to the U. S. National Museum.

KEY TO THE GENERA OF MALAYAN PORCUPINES.

a Tail short, less than one-fourth length of head and body; caudal hairs terminating mostly in hollow capsule-like structures, molars rootless, sacral vertebræ four ..... Subfamily HYSTRICINÆ, p. 578

b Dorsal profile of skull arched, nasals extending back to level of lachrymals, and contained into dorsal outline two and one-half times ..... *Acanthion*, p. 578

bb Dorsal profile of skull nearly straight, nasals extending back to level of anterior border of infraorbital foramen, contained into dorsal outline three and one-half times ..... *Thecurus*, p. 582

aa Tail long, one-third to one-half length of head and body, terminating in a tuft of modified bristles, molars rooted, sacral vertebræ three. Subfamily ATHERURINÆ, p. 584

c Each caudal scale subtended by three hairs, terminal bristles alternately expanded and contracted ..... *Atherurus*, p. 584

cc Each caudal scale subtended by a single hair, terminal bristles of uniform width throughout ..... *Trichys*, p. 588

Tabular view of the principal external and cranial characters of the genera of Old World porcupines.

Characters.	*Hystrix.*	*Acanthion.*	*Thecurus.*	*Atherurus.*	*Trichys.*
Tail short, less than one-fourth head and body	×	×	×		
Tail longer, one-third to one-half head and body				×	
Tail longer, one-half head and body					×
Caudal hairs terminating mostly in a hollow, open, capsule-like structure four to five times longer than wide	×	×			
Caudal hairs terminating mostly in a hollow, open or closed capsule-like structure three times longer than wide			×		
Caudal hairs, flattened bristles alternately expanded and contracted				×	
Caudal hairs, flattened bristles of uniform width throughout					×

Tabular view of the principal external and cranial characters of the genera of Old World porcupines—Continued.

Characters.	*Hystrix.*	*Acanthion.*	*Thecurus.*	*Atherurus.*	*Trichys.*
A mane or crest of long bristles on nape and upper back	×				
Nape and upper back mainly covered with flattened, grooved spines		×			
Long quills (150 to 300 mm.), dark, with light rings, on lower back	×	×			
Long quills (130 mm.), dark, with light base and apex and grooved flattened spines on lower back					
No quills in pelage, all grooved flattened spines, a few long stiff bristles on lower back					
Width of a single nasal contained in its length less than three times	×				
Width of a single nasal contained in its length about four times		×			
Nasals extend backward on upper surface of skull as far back as squamosal roots of zygomata, contained in dorsal outline one and one-half times	×				
Nasals mainly confined to rostrum, back only to level of lachrymal, contained into dorsal outline two and one-half times					
Nasals confined to rostrum, back to anterior margin of infraorbital foramen contained into dorsal outline three and one-half times					
Malar thin but relatively very broad, without groove on lateral face	×	×	×	×	
Malar thick but relatively narrow, with well-marked groove on lateral face					
Inferior bar of infraorbital foramen slender					
Inferior bar of infraorbital foramen heavy					
Outer bar of infraorbital foramen heavy					
Outer bar of infraorbital foramen slender			×		
Zygomatic process of maxilla forming only a very slight support for malar					
Zygomatic process of maxilla forming a well-marked backward support for malar					
No interorbital constriction					
Interorbital constriction slightly indicated					
Evident, but slight interorbital constriction					
Well-marked interorbital constriction					
A depression on top of skull at meeting of sagittal and coronal sutures at a level posterior to squamosal roots of zygomata					
No depression on top of skull at meeting of sagittal and coronal sutures which meet on line with squamosal roots of zygomata		×	×	×	
Supero-posterior lateral aspect of maxilla angular	×				
Supero-posterior lateral aspect of maxilla rounded		×	×	×	×
Basi-occipito-sphenoid scarcely narrowed between pterygoids	×	×		×	
Basi-occipito-sphenoid much narrowed between pterygoids			×		
Well-marked fossa on outside of mandible just beneath condylo-coronoid notch					
No well-marked fossa on outside of mandible just beneath condylo-coronoid notch					
Number of dorsal vertebræ		14	14	14	16
Number of lumbar vertebræ[a]		5	5	5	5
Number of sacral vertebræ[a]		4	4	3	3
Number of caudal vertebræ[a]		15	17	24	25
Neural spine of axis large and much compressed laterally		×		×	×
Neural spine of axis much smaller, tri-prismatic in form			×		
Seventh cervical with a neural spine 2 to 3 times the length of the spine of the sixth					
Seventh cervical with a neural spine no longer than that of sixth			×		
Number of sternal segments		7	7	6	7
Molars rootless, hypsidont	×	×	×		
Molars rooted, brachydont					

[a] Apparently there is some variation in the number of vertebræ, especially lumbar, sacral, and caudal. See Cederblom, Zool. Jahrb., XI, 1897–98, p. 499.

Subfamily HYSTRICINÆ.

The subfamily Hystricinæ is characterized among the Hystricidæ by having a short external tail, without a well-marked hairless scaly portion between its base and apex, in having the terminal hairs of the tail modified into hollow capsule-like structures, mostly open at the ends, in the possession of well-developed quills on the back, in having four sacral vertebræ, and rootless, hypsidont molars. It contains three genera: *Hystrix* (not considered in these notes, because not found in the Malayan subregion), *Acanthion*, page 578, and *Thecurus*, page 582.

ACANTHION F. Cuvier.

1822. *Acanthion* F. Cuvier, Mem. Mus. Hist. Nat. Paris, IX, 1822, p. 413, pl. xx bis, figs. 3, 4.

Type.—*Acanthion javanicum*, from Java.

Species.—*Acanthion brachyurum* (Linnæus), Malay Peninsula; *A. longicaudum* (Marsden), Sumatra; *A. javanicum* F. Cuvier, Java; *A. crassispinis* (Günther), Borneo.

Diagnostic characters.—Externally similar to *Hystrix*, but without a crest or mane and quills not so long. Cranially it differs in having much smaller nasals, extending back only as far as on a level with the lachrymal bones, and contained into the dorsal outline two and one-half times, instead of extending as far back as the squamosal roots of the zygomata and contained into the dorsal outline one and one-half times, as in *Hystrix*. No depression on upper surface of skull at the union of sagittal and coronal sutures. Molars rootless.

External characters.—Size large; head and body about 600 to 700 mm.; tail short, about one-fifth length of head and body. Upper surface of head clothed with stiff, rounded, bristly hairs, those on the nape considerably elongated, but not forming the well-defined mane or crest found in *Hystrix*. Upper half of back and shoulders covered with flattened spines, usually each with dorsal and sometimes ventral grooves. About the middle of the back these spines replaced by large heavy quills, light in color, with a single dark band near the middle or toward the basal side of the middle. The quills vary in length from 50 to 250 mm., and are longest toward the middle of the back, becoming quite short near the rump, where, however, they are still quills and bear no resemblance to the flattened spines found on the upper half of the back. On the base of the tail the quills become longer again. The distal portion of the tail is clothed with peculiar hairs. (Plate LVII, fig. 1.) The basal portion of each (10 to 15 mm.) is quite hair-like, but it abruptly expands out into a hollow cylinder, like an elongated capsule, about 5 mm. wide and about four to five times as long. Nearly always the ends of these capsule-like hairs are open, but rarely the sides of the capsule are prolonged to meet in a

pointed apex. The sides of head, the under parts, and the legs are in general covered with soft flattened spines similar to those in the upper back, but shorter and not so stiff.

Skeleton.—The main features of the skull of the genus *Acanthion* have previously been pointed out. The relative size and shape of the skull and of its various parts are clearly shown in fig. 5, Plates LIV, LV, and LVI, so that no detailed description is necessary here. The vertebral formula is Cv. 7, D. 14, L. 5, S. 4, Cd. about 15. The axis bears a large rectangular neural spine, projecting backward as a thin plate of bone, laterally compressed. (Plate LVII, fig. 11.) The seventh cervical bears a long pointed neural spine, about three times the length of the neural spine in front of it, and about half the size of the first dorsal spine. The lumbar vertebræ have large rectangular lateral processes, directed forward. (Plate LVII, fig. 12.) The first and half of the second sacral vertebræ serve for the attachment of the ilia. The presternum is relatively long, and its expanded part relatively narrow. The limb bones are relatively short and heavy, the scapulæ wide.

ACANTHION BRACHYURUM (Linnæus).

1758. [*Hystrix*] *brachyura* LINNÆUS, Systema Naturæ, I, 10th ed., p. 57. Based on SEBA, Rerum Nat. Thesaur., I, p. 81, pl. LII, fig. 1, from Java, Sumatra, and from Malacca. In view of Seba's name *Hystrix malaccensis* and his especial reference to its locality as Malacca, that country may properly be considered the type-locality.

1866. *Acanthochœrus grotei* GRAY, Proc. Zool. Soc. London, 1866, p. 310, pl. XXXI. Type-locality: Malacca. (See Proc. Zool. Soc. London, 1866, p. 417.)

1871. *Hystrix longicauda*, SCLATER, Proc. Zool. Soc. London, 1871, p. 234.

1900. *Hystrix longicauda*, FLOWER, Proc. Zool. Soc. London, 1900, p. 364.

1903. *Hystrix grotei*, BONHOTE, Fasc. Malay. Zool., I, July, 1903, p. 39, pl. III.

Distribution.—Malay Peninsula.

Diagnostic characters.—Apparently the largest of the Malayan species. Greatest length of skull, 135 to 150 mm.

Color.—Upper half of back, top of head, underparts, and legs and feet, an indefinite blackish brown or brownish black; a dirty white or dirty buff patch on throat, partly extended upward and backward along the side of neck. This is followed by a blackish brown collar and this in turn by a lighter collar, but this latter is not always well marked. The quills are dirty white or dirty buff in color, each with a band of blackish brown 20 to 30 mm. wide at or below the middle.

Skull.—The only peculiarity of the skull of this species apparently is its large size, total length of an old adult being 150 mm. and of a young adult about 140 mm.

Measurements.—See table, page 593.

Specimens examined.—One old female from Champang, Tenasserim; two adults and two young from Trong, Lower Siam.

ACANTHION LONGICAUDUM (Marsden).

1810. *Hystrix longicauda* Marsden, History of Sumatra, 3d ed., 1811, p. 118, name only, without description, and pl. XIII *n. l.* with legend: "The Landak, *Hystrix longicauda.* Published by W. Marsden 1810." Type-locality: Sumatra.

1871. *Hystrix mülleri* Marshall, Proc. Zool. Soc. London, 1871, p. 235, footnote. Type-locality: "Padang-bessie (Sumatra)." See Jentink, notes Leyden Museum, I, 1879, p. 91.

1879. *Hystrix mülleri* Jentink, Notes Leyden Museum, I, 1879, p. 89.

1888. *Acanthion mülleri*, Jentink, Cat. Syst. Mammifères, Mus. Hist. Nat. Pays-bas, XII, p. 104.

1905. *Hystrix longicauda*, Willink, Natuurkundig Tijdschrift Nederlandsch-Indië, LXV, p. 265.

1905. *Hystrix longicauda*, Schneider, Zool. Jahrb., Syst. Geogr. Biol., XXIII, p. 113.

Distribution.—Sumatra.

Diagnostic characters.—Similar to *Acanthion brachyurum*, but apparently slightly smaller; with less conspicuous throat collars.

Color.—As in *A. brachyurum*, but in the single available specimen the light throat collar very poorly defined and the sides of body are lighter in color, owing to the spines having lighter bases than in *A. brachyurum.*

Skull.—Evidently smaller than that of *A. brachyurum.* Jentink[a] gives the total length of the skull of an old male as 135 mm. The skull of a young male in the U. S. National Museum measures 103 mm. total length, against 110 mm. total length in a skull of the same age, as judged by the teeth, from the Malay Peninsula.

Measurements.—See table. page 593.

Specimens examined.—One, a young male, from Aru Bay, Sumatra.

Remarks.—Jentink[b] records *Acanthion mülleri* and *Acanthion javanicum* from Sumatra, Tanjong Morawa. No description of them is given, but it is to be supposed that they differ, as pointed out by Jentink[a] in 1879, mainly in size—in which case there are two distinct forms of *Acanthion* in Sumatra. That Jentink did not have a specimen of *Thecurus*, is evident from the fact that the smaller of his species, *A. javanicum*, has a skull length of 118 mm., while the skull length of *Thecurus* is scarcely more than 100 mm.

ACANTHION JAVANICUM F. Cuvier.

1822. *A*[*canthion*] *javanicum* F. Cuvier, Mem. Mus. Hist. Nat. Paris, IX, 1822, p. 431, pl. XX bis, figs. 3, 4. Type-locality: Java.

1836. *Hystrix torquata* van der Hoeven and de Vriese, Tijdscrift Natuur. Geschied. en Physiol., III, 1836, p. 110.

1844. *H*[*ystrix*] *brevispinosa* Wagner, Supplementband Schrebers Säugthiere, IV, p. 20.

[a] Notes Leyden Museum, I, 1879, p. 91.

[b] Idem, XI, 1889, p. 28.

1839–64. *H[ystrix] javanicum*, Blainville, Osteog. Mamm., IV, pl. II.
1848. *Hystrix javanica*, Waterhouse, Nat. Hist. Mamm., II, p. 465, pl. XX, fig. 4.
1854. *Acanthion javanicum*, Gervais, Hist. Nat. Mamm., p. 332.
1866. *Acanthion javanicum*, Gray, Proc. Zool. Soc. London, 1866, p. 310.
1871. *Hystrix javanica*, Marshall, Proc. Zool. Soc. London, 1871, p. 235, footnote.
1879. *H[ystrix] javanica*, Jentink, Notes Leyden Museum, I, 1879, pp. 87, 88.
1888. *Acanthion javanicum*, Jentink, Cat. Syst. Mammifères Mus. Hist. Nat. Pays-bas, XII, p. 103.
1905. *Hystrix javanica*, Willink, Natuurkundig Nederlandsch-Indië, LXV. p. 266.

Distribution.—Java.

Remarks.—I have seen no specimens of this species. There is a skeleton of an old individual in the National Museum, labeled "*Hystrix javanica;* Java." It was purchased from a dealer several years ago, and probably labeled "Java" because it had been identified as *Hystrix javanica*. The total length of the skull measures 135 mm. It is distinctly smaller than skulls of like age from the Malay Peninsula, but at the same time much larger than the 118 mm. given by Jentink[a] as the total length of a Javan *Acanthion* skull.

ACANTHION CRASSISPINIS (Günther).

1876. *Hystrix crassispinis* Günther, Proc. Zool. Soc. London, 1876, p. 736, fig. 1, p. 737; fig. 1*a*, p. 738; pl. LXX.
1893. *Hystrix crassispinis*, Hose, Mammals of Borneo, p. 60.
1905. *Hystrix crassispinis*, Willink, Natuurkundig Tijdschrift Nederlandsch; Indië, LXV, p. 266.

Distribution.—Borneo.

Diagnostic characters.—Size small; skull, total length 110 mm. Spines thick, equal twice the diameter of an incisor, longitudinally grooved on their upper surfaces.

Remarks.—I have seen no specimens of this species, but Günther's original description shows that it is a well-marked form. His plate would indicate that it is a lighter (browner) colored animal than either *Acanthion brachyurum* or *longicaudum*. His measurements show it to be a smaller animal than *A. javanicum*.

In *Mammals of Borneo*,[b] Hose records *Hystrix müllerí* Jentink, also from Borneo, saying: "This porcupine is like *Hystrix crassispinis*, but distinguished from it by its black belly and somewhat different caudal quills. The skull also differs, but the size of the animals are much the same." In all probability *A. crassispinis* has a dark belly, although there is nothing in the original description to show that the belly is light or dark. It is thus impossible to say how Hose's second species of short-tailed porcupines from Borneo differs from *Acanthion*

[a] Notes Leyden Museum, I, 1879, p 91. [b] Page 60.

crassispinis. It is possible that two or more species of the genus *Acanthion* are found on Borneo; but at present there is nothing in the literature to show this fact satisfactorily or to indicate what their characters are.

THECURUS, new genus.

Family.—Hystricidæ, subfamily Hystricinæ.

Type.—*Thecurus sumatræ*, new species. (Description on page 583.)

Species.—The type species is the only known one in the genus so far as known.

Diagnostic characters.—Externally like a small *Acanthion*, but capsule-like ends of caudal hairs, smaller and relatively shorter, often closed at the ends (Plate LVII, fig. 2), quills smaller, and replaced on lower rump by grooved spines similar to those on upper back. Cranially very similar to the genus *Atherurus*, but brain-case relatively wider, rostrum narrower, and no well-marked fossa on outer side of mandible just beneath condylo-coronoid notch; molars rootless.

External characters.—About half the size of *Acanthion*, to which it has a striking resemblance, but it has no bristly hairs on the head or neck, but merely soft, flattened spines. The flattened spines extend farther down the back than they do in *Acanthion* and are more conspicuously grooved, and they are also found on the lower back and rump instead of the short quills of *Acanthion*. The large heavy quills occupy about the third fourth of the back. They are much less numerous and shorter than those of *Acanthion*, the largest not exceeding 150 mm. These quills are dark in color, with a light base and apex. A very few long stiff bristles are interspersed among the quills. Some short quills are found on the base of the tail, while the terminal portion of that organ is covered with peculiar modified hairs, but the capsules are relatively much shorter and a great many more of them are closed at the apex—drawn out to a point. (Plate LVII, fig. 2.) The sides of the head, the underparts, and the legs, are in general clothed with rather soft, flattened, grooved spines.

Skeleton.—The main features of the skull of the genus *Thecurus* have previously been pointed out. The relative size and shape of the skull and its various parts are clearly shown in fig. 1, Plates LIV, LV, and LVI, so that no detailed description is here necessary. The vertebral formula is: Cv. 7, D. 14, L. 5, S. 4, Cd. 17. Although the skeleton of *Thecurus* as a whole, aside from the skull, is in general strikingly like that of *Acanthion*, yet in one or two points it is quite different. Instead of having a large, laterally compressed neural spine on the axis, that vertebra bears a relatively short, tri-prismatic spine, not compressed laterally any more than it is antero-posteriorly. (Plate LVII, fig. 9.) The seventh cervical vertebra in *Thecurus* has no long neural spine. The long neural spine on the seventh cervical seen in *Acan-*

thion has been shifted backward in *Thecurus* and is found on the first dorsal vertebra; the very long neural spine on the first dorsal of *Acanthion* occurs on the second dorsal in *Thecurus*. The lumbar vertebræ (Plate LVII, fig. 10) in *Thecurus* have large rectangular lateral processes, directed anteriorly much as in *Acanthion*, but the processes are rather more slender. The first and one-half of the second sacral vertebræ serve for the attachment of the ilia. The presternum is relatively shorter in *Thecurus* than in *Acanthion* and the expanded part is relatively wider. The limb bones are relatively short and heavy, proportioned as they are in *Acanthion*, but the anteriorly projecting "knee" at about the middle of the tibia is more pronounced. The scapula is somewhat wider, in proportion to size, in *Thecurus* than in *Acanthion*. It is almost identical in size and shape to the scapula of *Atherurus*.

THECURUS SUMATRÆ, new species.

Type.—Skin and skull of adult male, Cat. No. 143432, U.S.N.M., collected at Aru Bay, east coast of Sumatra, January 17, 1906, by Dr. W. L. Abbott. Original No. 4637.

Distribution.—Known only from the vicinity of Aru Bay, Sumatra.

Diagnostic characters.—The same as given for the genus above.

Color.—General color on top of head and anterior half of back, much like a dark drab of Ridgway, specked, especially on top of neck and toward the sides with the dirty white tips of the spines. Sides of head and neck and underparts drab, conspicuously specked with the dirty white tips of the spines. Under side of neck dirty white or cream-buff, crossed by a drab collar 25 to 30 mm. wide. The feet and legs are darkened almost to Ridgway's seal brown. The quills are blackish, with dirty whitish tips of 20 to 25 mm. Spines on the lower back blackish with short (about 5 mm.) light-colored tips.

Skull and teeth.—The characters of the skull have already been described. The skulls as a whole show a great deal of individual variation in respect to size, comparative width of skull, and length of nasals. (See table of measurements, p. 593.) The teeth show equal variation in size, No. 143434 having the length of upper toothrow 19.5 mm. and No. 143435, with teeth worn to the same extent, 17.2 mm. Wear produces very striking effects on the teeth; reentrant angles seen in the young and in the young adults are entirely lost in old individuals, and judging by the teeth alone one might easily consider young and aged adults to belong to different genera.

Measurements.—External measurements. (See table, p. 593.) Cranial measurements of the type: Basal length, 92.3 mm.; basilar length, 85; condylo-basal length, 99.4; greatest length, 108; upper length, 103.7; palatal length, 51.3; zygomatic breadth, 56; distance between outer margins of external auditory meatus, 42.8; interorbital constric-

tion, 31.8; greatest length of nasal, 29.6; width of both nasals together, 15; maxillary toothrow (alveoli), 19.3; mandibular toothrow (alveoli), 19.5.

Specimens examined.—Nine skins with skulls, one odd skull, and one skeleton, all from Aru Bay, east coast of Sumatra.

Remarks.—*Thecurus sumatræ* is a very distinct form of porcupine and apparently bears little resemblance to other described genera or species. Externally it closely resembles a small *Acanthion*, while cranially it has so many points in common with *Atherurus* that there are almost no characters, aside from rootless molars, by which the two may be generically separated. In many respects it is an intermediate link between *Acanthion* and *Atherurus*.

In 1879[a] Doctor Günther described a small porcupine from the island of Paragua, Philippine Islands, under the name of *Hystrix pumila*. I have seen no specimens of this species nor any figures of it, but the original description and the detailed measurements given lead me to believe that *Hystrix pumila* is closely related to *Thecurus sumatræ* and may possibly be a second species of that genus. Whatever the relationship, Doctor Günther's measurements indicate that *Hystrix pumila* is a distinctly smaller animal than *Thecurus sumatræ*.

Subfamily ATHERURINÆ.

The subfamily Atherurinæ is distinguished among the Hytricidæ in the possession of a rather long external tail, with a well-marked scaly portion between its base and apex, which is terminated by a long tuft of modified hairs or bristles; in not having well-developed quills on the back, but merely stiff grooved spines; in having three sacral vertebræ and rooted, brachydont molars. It contains two genera: *Atherurus*, page 584, and *Trichys*, page 588.

ATHERURUS F. Cuvier.

1829. *Atherurus* F. Cuvier, Dict. Sci. Nat., LIX, p. 483.

Type.—*Hystrix macroura* Linnæus, from Malacca.[b]

Species.—(In Malayan region) *Atherurus macrourus* (Linnæus), from Malacca; *A. zygomaticus* Miller, from Pulo Aor; and *A. terutaus*, new (page 587) Pulo Terutau.

Diagnostic characters.—A small sized porcupine, without quills, with a large scaly tail, each scale subtended by three hairs, and terminated by a tuft of bristles, mostly flattened and alternately contracted and expanded one to five times. (Plate LVII, fig. 3.) Skull

[a] Ann. Mag. Nat. Hist., IV, 1879, p. 106.

[b] See Jentink, Notes Leyden Museum, XVI, 1894, p. 207, Lyon, Proc. Biol. Soc. Washington, XIX, December 31, 1906, p. 199, and Thomas, Proc. Biol. Soc. Washington, XX, p. 66, June 12, 1907.

in many respects like that of *Thecurus*, but relatively narrower and with less abrupt rostrum, and with a well marked fossa on side of mandible beneath the condylo-coronoid notch and with rooted molars. Differs from the skull of *Trichys* in the absence of postorbital processes, and in having distinctly heavier malars.

External characters.—Size small, a little less that of *Thecurus*, tail long, about one third head and body. Entire upper parts and sides of body and base of tail covered with heavy, somewhat flattened spines, with a large groove on their dorsal aspect, and a shallow groove on their underside at the base. The spines are longest on the lower back, rump, and base of tail where they are about 75 mm. long. No quills proper are found on this porcupine, but interspersed among the flattened, grooved spines on the lower back are a few rounded stiff bristles, somewhat quill-like at the base, having a length of 100 to 125 mm. The head, underparts, and the legs, are clothed with soft, flat spines. The basal fourth of the tail is covered with spines, like those of the lower back; the middle two-fourths are covered with scales, each of which is subtended by three short hairs, a median stiff, long one, with a shorter finer one on either side; the terminal fourth of the tail is mainly covered with peculiar flattened hollow hairs and some ordinary bristles. Each of these peculiar hairs begins with a hair-like base, but soon expands into a small, narrow, hollow, flattened capsule, followed by a short hair-like space and then another flat, hollow capsule, some hairs having as many as five such expansions. These hairs always terminate in an expansion with a long drawn-out apex. (Plate LVII, fig. 3.)

Skeleton.—The main features of the skull of the genus *Atherurus* have previously been pointed out. The relative size and shape of the skull and of its various parts are clearly shown in fig. 2, Plates LIV, LV, and LVI, so that no detailed description is here necessary. The vertebral formula is Cv. 7, D. 14, L. 5, S. 3, Cd. 24. The axis bears a large neural spine flattened from side to side, similar to that found in *Acanthion*, but subtriangular in outline and directed backward at a sharper angle. (Plate LVII, fig. 7.) The seventh cervical has a short neural spine, like that of the sixth, and the long spine of the seventh seen in *Acanthion* has been shifted backward to the first dorsal, as in *Thecurus*. The lumbar vertebræ have rather narrow lateral processes, directed forward at a more acute angle than they are in the two preceding genera, and the ends of the processes are somewhat enlarged. (Plate LVII, fig. 8.) Only three vertebræ compose the sacrum in *Atherurus*, and the first alone serves for the attachment of the ilia. The presternum is relatively short, and its expanded portion relatively narrow. The humerus is relatively more slender in *Atherurus* than it is in *Acanthion* or *Thecurus;* the deltoid ridge is less promi-

nent, and the olecranon process of the ulna is shorter. The femur, tibia, and fibula are proportioned about as they are in the two preceding genera, but the metatarsals and phalanges are relatively longer. The scapula of *Atherurus* is broad.

ATHERURUS MACROURUS (Linnæus).

1758. [*Hystrix*] *macroura* Linnæus, Systema Naturæ, 10th ed., I, p. 57. Based on Seba, Rerum Nat. Thesaur, I, p. 84, pl. lii, fig. 1. Locality not known, other than East Indies.[a]

1801. *Hystrix macroura*, Shaw, Gen. Zool., II, Pt. 1, p. 9, pl. cxxiv.

1830. *Atherura fasciculata*, Bennett, Gardens and Menagerie Zool. Soc. London, pp. 175–178.

1839–64. *H*[*ystrix*] *fasciculata*, Blainville, Osteog. Mamm., IV, pl. ii.

1844. *H*[*ystrix*] *fasciculata*, Wagner, Supplementband Schrebers Säugthiere, IV, p. 23.

1844. *Hystrix macroura*, Wagner, Supplementband Schrebers Säugthiere, IV, pl. clxx.

1848. *Atherura macroura*, Waterhouse, Nat. Hist. Mamm., II, p. 472.

1854. *Atherurus fasciculatus*, Gervais, Hist. Nat. Mamm., p. 333.

1876. *A*[*therura*] *macroura*, Günther, Proc. Zool. Soc. London, 1876, p. 742, fig. 3.

1879. *H*[*ystrix*] *macroura*, Jentink, Notes, Leyden Museum, I, 1879, p. 87.

1891. *Atherura macrura*, Blanford, Fauna British India, Mamm., p. 446.

1894. [*Atherura*] *macroura*, Jentink, Notes, Leyden Museum, XVI, 1894, p. 207.

1905. *Atherura macroura*, Willink, Natuurkundig Tijdschrift Nederlandsch Indië, LXV, p. 267.

Distribution.—Malay Peninsula, Burma, and perhaps various Malayan Islands.

Color.—General effect of top of head, upper back, and of feet, Ridgway's drab, rather dark. The heavier spines are a blackish brown. On the sides, thighs, and underparts the spines have dull, dirty whitish bases and subterminal apical bands, with a drab or drab-gray band between them, and a very slight drab-gray apex. The chin and upper throat are particularly light, as well as an ill-defined band across the chest. The light color of the bases and of the subterminal rings of the spines show to a marked extent on the sides and underparts. The tuft of bristles at end of tail vary from dirty whitish to a dirty cream buff.

Measurements.—See table, page 593.

Specimens examined.—Four, from Trong, Lower Siam.

[a] Seba's figure shows an animal much less spiny than any Malayan specimens I have seen. The description of the tail does not agree with specimens of this genus in the U. S. National Museum. Seba likens the swelling on the caudal bristles to grains of rice inclosed in an envelope. In the specimen at hand each bristle, while hollow, is flat and alternately widened and contracted laterally in one plane only, and the expansions are much longer than are the enlargements shown in Seba's figure. It is barely possible that the animal usually designated as *Atherurus macrourus* (Linnæus) is really an undescribed species. At least it would so appear if Seba's account is at all accurate.

ATHERURUS ZYGOMATICUS Miller.

1903. *Atherura zygomatica* Miller, Smithsonian Miscell. Coll., XLV, November 6, 1903, p. 42, pl. II, fig. 4. Type-locality: Pulo Aor, off coast of Johore.

Distribution.—Known only from Pulo Aor, off coast of Johore.

Type.—Adult female, skin and skull, Cat. No. 112429, U.S.N.M., collected on Pulo Aor, off coast of Johore, June 6, 1901, by Dr. W. L. Abbott, Original No. 1009.

Diagnostic characters.—Like *Atherurus macrourus*, but color darker, and zygoma shorter and deeper, under side of malar bone with a conspicuous tooth-like process directed backward, lachrymal bone much smaller, scarcely appearing on dorsal aspect of skull.

Color.—Very similar to that of *Atherurus macrourus*, but slightly darker, especially along the sides, due to the light area of the spines being less in evidence.

Skull and teeth.—In general, the skull is very similar to that of *Atherurus macrourus* of the Malay Peninsula, but in size it is somewhat smaller and differs conspicuously in regard to the lachrymal bones and the zygomata.

In *Atherura macroura* the lachrymal is fully 8 mm. in length below the rim of the orbit, while above it extends forward as a triangle of bone at least 5 mm. long, and is a noticeable feature of the dorsal aspect of the skull. In *A. zygomatica* its length below rim of orbit is usually about 5 mm., * * * while the forward extension is often obsolete and never large enough to be more than barely visible when the skull is viewed from above. Zygoma shorter than in *Atherura macroura*, the jugal deeper in proportion to its length, more abruptly concaved above, and its lower contour invariably * * * broken by a strongly developed concavity beneath posterior jugal suture, this concavity terminating anteriorly on the posterior upper surface of a well-marked tooth-like projection.[a]

Measurements.—For a comparison of the cranial measurements of the type, with the type of *Atherurus terutaus* and with an adult female from Trong, Lower Siam, see page 588. For measurements of the series, see table, page 593.

Specimens examined.—Seven; all from Pulo Aor.

ATHERURUS TERUTAUS, new species.

Type.—Skin and skull of adult male, Cat. No. 123971, U.S.N.M., collected on Pulo Terutau (also written Trotau and Trotto), about 15 geographical miles west of the Malay Peninsula, where the one hundredth meridian east of Greenwich cuts the west coast of the Malay Peninsula, April 10, 1904, by Dr. W. L. Abbott. Original No. 3223.

Diagnostic characters.—Like *Atherurus macrourus* of the Malay Peninsula, but smaller, with shorter tail; lachrymal bone much smaller, scarcely appearing on the dorsal aspect of the skull. It

[a] Miller, Smithsonian Miscell. Coll., XLV, p. 42, November 6, 1903, and especially Plate II, figs. 4 and 5, where the above characters are well shown.

resembles *A. zygomaticus* from Pulo Aor in its small lachrymal, but lacks the heavy zygoma and the step-like projection on its inferior border. Caudal bristles shorter than in either *A. macrourus* or *A. zygomaticus*, and with the single (in the other species these are usually three to five on a bristle) expansion relatively narrower and longer. The bristles, however, have a worn appearance, which might account for this difference.

Color.—The color of *Atherurus terutaus* so closely resembles that of *A. zygomaticus* that no detailed description is necessary.

Skull and teeth.—In general, similar to those of *Atherurus macrourus*, but distinctly smaller, rostrum and nasals relatively shorter, constriction between the orbits more pronounced, depression on top of skull greater; lachrymal bone much smaller, scarcely any of it appearing on the dorsal aspect of the skull; in this respect resembling the skull of *A. zygomaticus;* zygomata of the same form as in *A. macrourus*; audital bullæ, smaller. Teeth of same form as in *A. macrourus*, but smaller.

Measurements.—See table, page 593. Cranial measurements of the type: Greatest length, 93.2 mm. (94.3, 99);[a] basal length, 82.2 (82.6, 87.4); basilar length, 76.1 (75.6, 80.5); condylo-basal length, 87.8 (89, 94.2); palatal length, 44.7 (45.5, 47.6); greatest length of nasal, 22 (25.3, 26.3); zygomatic breadth, 45.8 (45.3, 47.5); least interorbital breadth, 24.5 (26.1, 28.4); maxillary toothrow (alveoli), 15.7 (17.1, 17.2); mandibular toothrow (alveoli), 17.3 (17.9, 18.8).

Specimens examined.—One, the type.

Remarks.—Although but one specimen of *Atherurus terutaus* is known, its peculiarities are so well marked that its specific distinctness from *A. macrourus* and *A. zygomaticus* can not be doubted. It possesses the peculiar lachrymal bones of *A. zygomaticus*, but its zygomata are exactly as they are in *A. macrourus* from the mainland.

TRICHYS Günther.

1876. *Trichys* GÜNTHER, Proc. Zool. Soc. London, 1876, p. 739, fig. 2; p. 740, fig. 2*a*, p. 741 and pl. LXXI.

Type.—*Trichys lipura*, from Borneo.

Species.—*Trichys fasciculata* (Shaw), from Malacca; *T. lipura* Günther, from Borneo; *T. macrotis* Miller, from Sumatra.

Diagnostic characters.—A small porcupine externally resembling *Atherurus* but with a relatively longer tail, each scale of which is subtended by a single hair and with the brush at end of tail composed of flat, grooved bristles, with parallel sides. (Plate LVII, fig. 4.) Skull small, different from that of *Atherurus* in possessing distinct postorbital

[a] Measurement in parentheses are those of the type of *Atherurus zygomaticus* Miller, from Pulo Aor, and of an adult female, Cat. No. 84433, U.S.N.M., of *A. macrourus*, from Trong, Lower Siam.

processes, a more slender and pronounced rostrum, zygomata more converging anteriorly, and a heavy grooved malar of nearly uniform width throughout its length, which is subtended by a considerable backward extension of the maxillary portion of the zygoma. Molars rooted.

Description of skin.—Size small, somewhat less than that of *Atherurus*, tail relatively longer. Upper parts and sides of body covered with spines more flat and less stiff than in *Atherurus*, grooved both above and below, of about the same length (25 to 30 mm.) all over the back. Interspersed among them are a very few stiff bristles, about 75 mm. long. The head, underparts, and the legs are covered with softer, shorter bristles. The extreme base of the tail is covered with spines like those on the back. The greatest portion of the tail is covered with well-defined scales, each subtended by a single hair. Toward the tip the scales grow larger and the subtending hairs become longer (about 100 mm.), flat, hollow bristles of uniform width throughout their extent. (Plate LVII, fig. 4.)

Skeleton.—The main features of the skull of the genus *Trichys* have previously been pointed out. The relative size and shape of the skull and of its various parts are clearly shown in fig. 3, Plates LIV, LV, and LVI, so no detailed description is here necessary. The vertebral formula is: Cv. 7, D. 16, L. 5, S. 3, Cd. 25. The axis bears a large laterally-compressed neural process, strongly curved and bent backward. (Plate LVII, fig. 5.) The neural spine of the seventh cervical is short as it is in *Thecurus* and *Atherurus*. The lateral processes of the lumbar vertebræ are rather slender, curved, and directed forward, and with a somewhat pointed apex. (Plate LVII, fig. 6.) The sacrum is of form similar to that of *Atherurus;* it contains three vertebræ, and to the first of these the ilia are attached. The presternum is relatively short, and with a relatively narrow anterior expansion. The humerus and the bones of the forearm are proportioned as they are in the genus *Atherurus*. The femur is relatively more slender in *Trichys* than in the other genera, and the metatarsals and phalanges are somewhat longer than they are in the genus *Atherurus*. In *Trichys* the scapula is much narrower than in the other genera, and its anterior border is strongly rounded off.

TRICHYS FASCICULATA (Shaw).[a]

1801. *Hystrix fasciculata*, Shaw, Gen. Zool., II, Pt. 1, Mamm., p. 11, pl. cxxiv. Type-locality: Malacca.

1830. *Atherura fasciculata*, Bennett, Gardens and Menagerie Zool. Soc. London, pp. 175–178.

[a] While these notes have been going through the press Mr. Oldfield Thomas (Proc. Biol. Soc. Washington, XX, p. 66, June 12, 1907) has attempted to show that *Hystrix fasciculata* Shaw, based on Buffon's *Porc-épic de Malaca*, is a synonym of *Hystrix macroura* Linnæus. Although Mr. Thomas is probably right in his conclusion as to

1839–1864. *H[ystrix] macroura*, Blainville, Osteog. Mamm., IV, pl. II.
1841. *Acanthion macrourum*, Gervais, Voyage autour du Monde sur la Bonite, pp. 60–63, Atlas, pl. XI.
1848. *Atherura fasciculata*, Waterhouse, Nat. Hist. Mamm., II, p. 470.
1854. *Atherurus macrourus*, Gervais, Hist. Nat. Mamm., p. 333.
1876. *A[therura] fasciculata*, Günther, Proc. Zool. Soc. London, 1876, p. 742.
1879. *H[ystrix] fasciculata*, Jentink, Notes, Leyden Museum, I, 1879, p. 87.
1894. *Trichys fasciculata*, Jentink, Notes, Leyden Museum, XVI, 1894, p. 205.
1900. *Trichys lipura*, Bonhote, Proc. Zool. Soc. London, 1900, p. 881.

Distribution.—Malay Peninsula.

Remarks.—I have seen no specimens of this species which has usually been considered synonymous with the Bornean *Trichys lipura*. Because of the general distinctness of mammals of the Malay Peninsula and those from Borneo, that view does not appear probable, and, both animals having been named, those names are here retained. It is possible, on the other hand, that the Sumatran *Trichys macrotis* may be very close to the Malay Peninsula animal.

TRICHYS LIPURA Günther.

1876. *Trichys lipura* Günther, Proc. Zool. Soc. London, 1876, p. 739; fig. 2, p. 740; fig. 2a, p. 741; pl. LXXI. Type-locality: Borneo, opposite Island of Labuan, see p. 424 of the foregoing reference.
1889. *Trichys lipura*, Günther, Proc. Zool. Soc. London, 1889, p. 75.
1889. *Trichys guentheri* Thomas, Proc. Zool. Soc. London, 1889, p. 235. A new name proposed for *T. lipura*, because the animal normally possesses a tail.
1893. *Trichys lipura*, Hose, Mammals of Borneo, p. 61.
1894. *Trichys fasciculata*, Jentink, Notes, Leyden Museum, XVI, 1894, p. 208.
1903. *Trichys fasciculata*, Miller, Proc. U. S. Nat. Mus., XXVI, p. 469.
1905. *Trichys fasciculata*, Willink, Natuurkundig Tijdschrift Nederlandsch-Indië, LXV, p. 267.

Distribution.—Borneo.

Color.—General color above a sort of drab-brown. The bases of the spines are whitish, which is the general color of the underparts owing to absence of drab-brown tips of the spines. On the sides the color gradually passes from the almost complete drab-brown of the upper parts to the whitish of the belly.

Skull and teeth.—These are well figured by Günther,[a] and need no detailed description here.

Buffon's *Porc-épic de Malaca*, I think he is in error in saying that the genus *Trichys* is not known in Malacca, for it seems to have been clearly recorded from the Malay Peninsula by Bonhote (Proc. Zool. Soc. London, 1900, p. 881) and by Jentink (Notes Leyden Museum, XVI, 1894, p. 207). If *Hystrix fasciculata* Shaw is a synonym of *Hystrix macroura* Linnæus, the species of *Trichys* on the Malay Peninsula (if it is distinct from the Bornean and Sumatran animals, as is probable) has not yet received a valid name. Having seen no specimens of *Trichys* from the Malay Peninsula, I can not venture to state whether it is distinct from the two species already named or with which one it should be associated. Accordingly I have left the matter standing as originally written, but with this explanation.

[a] Proc. Zool. Soc. London, 1876, pp. 740 and 741.

Measurements.—See table, page 593.

Specimens examined.—Two, skin and skull of nearly adult male from Mount Salikan, Borneo, and the skeleton of an adult from British North Borneo.

TRICHYS MACROTIS Miller.

1903. *Trichys macrotis* MILLER, Proc. U. S. Nat. Mus., XXVI, p. 469, February 3, 1903. Type-locality: Tapanuli Bay, west coast of Sumatra.

1905. *Trichys macrotis*, WILLINK, Natuurkundig Tijdschrift Nederlandsch-Indië, LXV, p. 268.

Distribution.—Sumatra.

Type.—Skin and skull of adult female, collected at Tapanuli Bay, west coast of Sumatra, February 20, 1902, by Dr. W. L. Abbott. Original No. 1555.

Diagnostic characters.—Like *Trichys lipura* from Borneo, but with longer ears, more angled hamulars, and smaller lachrymal bone.

Color.—The color of *Trichys macrotis* differs in no way from that of *T. lipura*.

Ears.—The ears in *Trichys macrotis* are much longer than they are in *T. lipura*, and the tips broader and more rounded. Length of ear from meatus in the type of *T. macrotis*, 28 mm., in *T. lipura*, Cat. No. 83940, from Borneo, 18 mm.

Skull.—The skull closely resembles that of *Trichys lipura*, but the hamular process of the pterygoid bone has a more pronounced bend or angle on its inferior aspect, and the tip, instead of ending in a point barely in contact with the audital bulla, is considerably thickened and generally in contact with the bulla. The lachrymal bone is apparently much longer in the Bornean animal than in *T. macrotis*, although in many specimens of the latter species the sutures are so obliterated as to render it impossible to determine its exact size. Greatest length of the lachrymal bone in the two Bornean skulls, 8 and 9 mm. respectively, in four Sumatran skulls, 4 to 5.5 mm.

Measurements.—See table page 593.

Specimens examined.—Seven, 5 from Tapanuli Bay and 2 from Aru Bay, Sumatra.

RELATIONSHIPS OF THE FOUR GENERA OF MALAYAN PORCUPINES.

The most primitive and unrelated to the others of the Malayan porcupines is the genus *Trichys*. Externally *Trichys* and *Atherurus* are much alike, but the terminal tail bristles of *Trichys* are peculiar and bear no distinct relation to those of *Atherurus* or to the other genera. Both *Trichys* and *Atherurus* have rooted molars, while the molars in the other two genera are rootless. Osteologically *Trichys* shows many peculiarities not possessed by the other genera, such as the generalized form of the skull, large number of dorsal vertebrae and narrowed

scapulæ. Its skull and teeth show resemblances to those of *Atherurus*, and the sacra in the two genera are practically identical. *Atherurus*, although showing strong affinities to *Trichys*, appears in certain ways to be related to *Thecurus*. Most of the skeleton of *Atherurus* is much like that of *Thecurus*, the only striking difference being in the lessened number of sacral and caudal vertebræ in *Atherurus*, and in the peculiar axis of *Thecurus*, which does not resemble in any way the axis of any of the other three genera. The caudal bristles of *Atherurus* might have been derived from those of *Thecurus*, or the reverse. If the caudal bristles of *Atherurus* had but one enlargement, and that more inflated and less flattened, they would be of the type found in *Thecurus*. *Thecurus* differs from any of the other three genera by its peculiar axis. Without its skull and axis it could not be differentiated from *Acanthion*, while if only its skull were known there would be little excuse for separating it from *Atherurus*, provided no account were taken of its rootless molars. *Acanthion* is clearly closely related to *Hystrix* and less different from that genus than it is from *Thecurus*, *Atherurus*, or *Trichys*. The five genera of Old World porcupines may be arranged serially thus:

Hystrix * *Acanthion* * * *Thecurus*——*Atherurus* * * * * *Trichys*, with the most different genera at the extremes of the line and the most closely related next to one another. A break occurs between *Thecurus* and *Atherurus* so that two subfamilies may be recognized. *Hystrix* and *Acanthion* are evidently directly and closely related to one another, and *Thecurus* is certainly much closer to them than it is to the *Atherurus-Trichys* group. Whether *Atherurus* and *Trichys* are directly related to each other or are only distantly so related through a remote ancestry is difficult to say. The two subfamilies, Hystricinæ and Atherurinæ are scarcely of equal rank, the members of the former being much more homogeneous than those of the latter. *Trichys*,[a] with its generalized structure is evidently the most primitive of the Hystricidæ and at the opposite end stands *Hystrix* (Plates LIV, LV, and LVI, fig. 4), the most specialized, with its peculiar much modified skull and highly developed quills.

[a] See Cederblom, Zool. Jahrb., XI, 1897–98, p. 513, and Winge, Jordfundne og nulevende Gnavere, Lagoa Santa, Brasilien, 1887, pp. 128, 129.

Table of external and cranial measurements of Malayan porcupines.

Name.	Locality.	Number.	Sex and age.	Head and body.	Tail.	Hind foot with claws.	Greatest length of skull.	Zygomatic width.	Greatest length of nasals.
				mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Acanthion javanicum.	Java?	*a* 22974	Old	*b* 670	*b* 175	*b* 95	135	68	56.4
Acanthion brachyurum.	Champang, Tenasserim.	*c* 124020	Female, old	*d* 725	*d* 140	*e* 112.5	150	.....	.....
Do	Trong, Lower Siam.	*c* 83521	Male, adult	*d* 711	*d* 114	*e* 85	142.5	61	58.4
Do	do	*c* 83519	Female, adult	*d* 635	*f* 64	*e* 92	134	66.6	58
Do	do	*g* 49465	Young *h*	.....	.....	.....	132	65	58.5
Do	do	*c* 83520	Young, male *i*	*e* 480	*e* 85	*e* 80	110	59	42
Acanthion longicaudum.	Aru Bay, Sumatra.	*c* 143431	do	*d* 515	*d* 95	*e* 72	103	55	41.5
Thecurussumatræ	do	*cj* 143432	Male, old	*d* 540	*d* 100	*d* 70	108	56	29.6
Do	do	*c* 143433	do	*d* 495	*d* 90	*d* 70	102.3	56.1	31
Do	do	*c* 143434	do	*d* 540	*d* 110	*d* 71	105.8	56	29.7
Do	do	*c* 143435	Female, old	*d* 455	*d* 90	*d* 68	99.5	49.1	34.9
Do	do	*c* 143438	do	*d* 525	*d* 90	*d* 73	102.3	53.2	30
Do	do	*c* 143439	do	*d* 500	*f* 30	*d* 70	98.6	55	29.5
Do	do	*a* 49870	Male, old	*b* 480	*b* 110	*b* 70	97.6	53	31
Do	do	*g* 143454	Male, adult	*d* 490	*d* 90	.....	98.7	52.5	30.1
Do	do	*c* 143430	do	*d* 550	*d* 110	*d* 75	108.6	53.2	32
Do	do	*c* 143436	Female, adult	*d* 495	*d* 100	*d* 73	102.6	50.6	29.6
Do	do	*c* 143437	Female, young *h*	*d* 450	*d* 95	*d* 62	93.7	47.8	25
Atherurus macrourus.	Trong, Lower Siam.	*a* 49498	Old	*b* 480	*b* 240	*b* 70	101.6	48.2	28.2
Do	do	*c* 84433	Female, old	*d* 445	*d* 229	*e* 66	99.2	47.7	26.2
Do	do	*c* 83500	Female, adult	*d* 482	*d* 203	*e* 65	98.1	44.7	27.4
Do	do	*c* 84432	Male, young *k*	*d* 470	*d* 231	*e* 65	91.9	43.2	25.0
Atherurus zygomaticus.	Pulo Aor	*c* 112432	Male, old	*d* 485	*dl* 65	*e* 64	96.5	46.4	24.3
Do	do	*c* 112433	do	*d* 510	*dl* 40	*e* 65	99.6	45.3	27.8
Do	do	*cj* 112429	Female adult	*d* 520	*d* 200	*e* 67	94.3	45.4	25.6
Do	do	*c* 112431	do	*d* 500	*d* 145	*e* 66	95.9	45.8	28.6
Do	do	*c* 112434	Female, old	*d* 500	*dl* 40	*e* 64	93.7	46.2	26.1
Do	do	*a* 49602	Adult	*b* 480	*b* 175	*b* 65	94.4	46.1	26.5
Do	do	*c* 112430	Female, young *h*	*d* 470	*d* 190	*e* 62	88.9	41.4	24.1
Do	do	*c* 112435	Male, young *k*	*m* 470	*m* 170	*m* 63	86.4	41	21
Atherurus terutaus.	Pulo Terutau	*cj* 123971	Male, adult	*d* 440	*d* 110	*e* 62	93.1	45.7	22
Trichys lipura	Mount Salikan, Borneo	*c* 83940	Male, nearly adult.	*e* 450	*e* 175	.....	83.7	43.8	25.6
Do	British North Borneo.	*a* 34785	Adult	*b* 350	*b* 230	*b* 65	83.4	44	27.1
Trichys macrotis	Tapanuli Bay, Sumatra.	*c* 114489	Male, old	*d* 410	*d* 180	*e* 64	82.7	44	26.3
Do	do	*c* 114490	Male, adult	*d* 415	*d* 185	*e* 62	83.4	44.3	27.4
Do	do	*c* 114487	Female, old	*d* 425	*dl* 30	*e* 64	85	42.4	26
Do	do	*cj* 114488	do	*d* 428	*d* 225	*e* 65	82.5	43.5	26.5
Do	do	*c* 114491	Female adult	*d* 422	*d* 195	*e* 60	81.8	43	25.2
Do	Aru Bay, Sumatra.	*c* 143441	do	*d* 415	*d* 200	*e* 60	78	42.8	22.4
Do	do	*c* 143440	Female, immature. *h*	*d* 420	*d* 220	*e* 65	79.7	44.2	22.7

a Skeleton.
b Estimated from skeleton.
c Skin and skull.
d Collector's measurements.
e Measured from skin.
f Tail injured.
g Skull only.
h Last upper molars just coming into place.
i Second upper molars just coming through alveoli.
j Type.
k Last molar not through alveolus.
l Tail damaged. The loss of the external tail seems to be of rather common occurrence among the long-tailed porcupines, and shows of how little practical use that organ is to them.
m Estimated from mounted skin.

EXPLANATION OF PLATES.

PLATES LIV, LV, AND LVI.

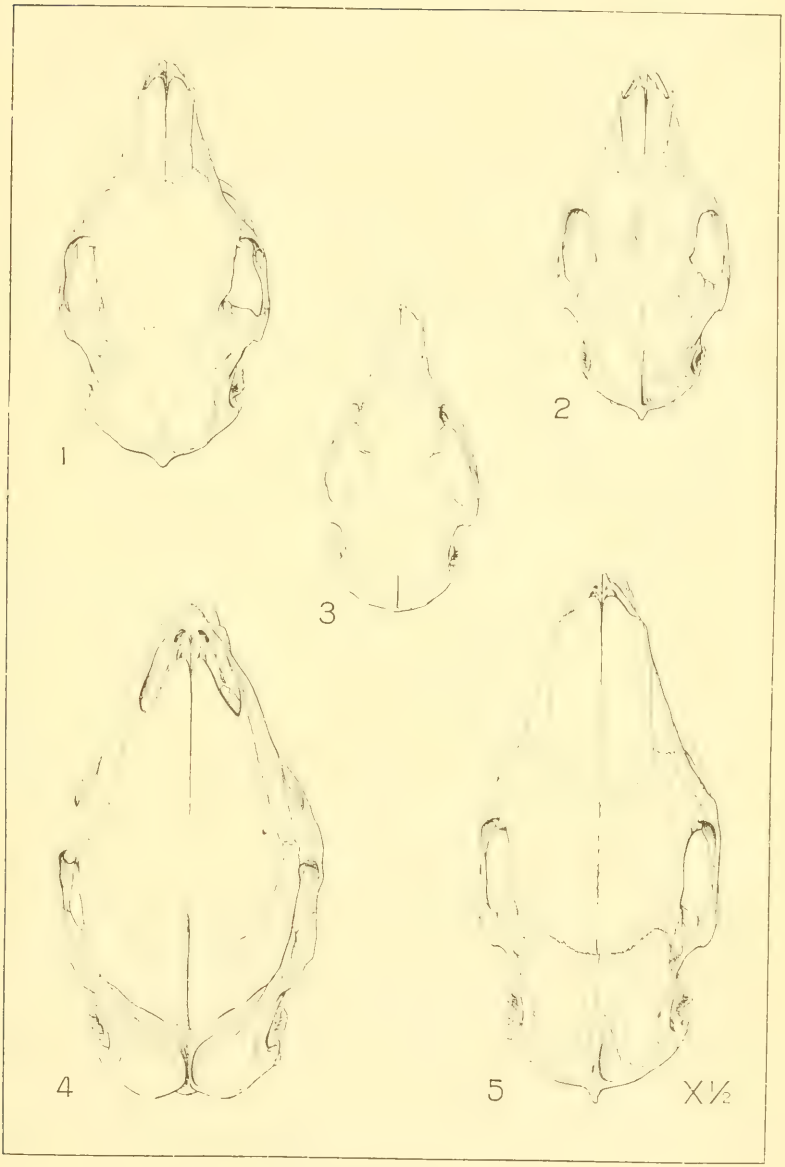
Dorsal, lateral, and ventral views of skulls of Old World porcupines. All figures one-half natural size.

Fig. 1. *Thecurus sumatræ*. Type, Cat. No. 143432, U.S.N.M., Aru Bay, Sumatra.
2. *Atherurus terutaus*. Type, Cat. No. 123971, U.S.N.M., Pulo Terutau, west coast Malay Peninsula.
3. *Trichys macrotis*. Type, Cat. No. 114488, U.S.N.M., Tapanuli Bay, Sumatra.
4. *Hystrix cristata*. Cat. No. $\frac{49348}{60048}$, U.S.N.M., received from National Zoological Park.
5. *Acanthion brachyurum*. Cat. No. 83519, U.S.N.M., Trong, Lower Siam.

PLATE LVII.

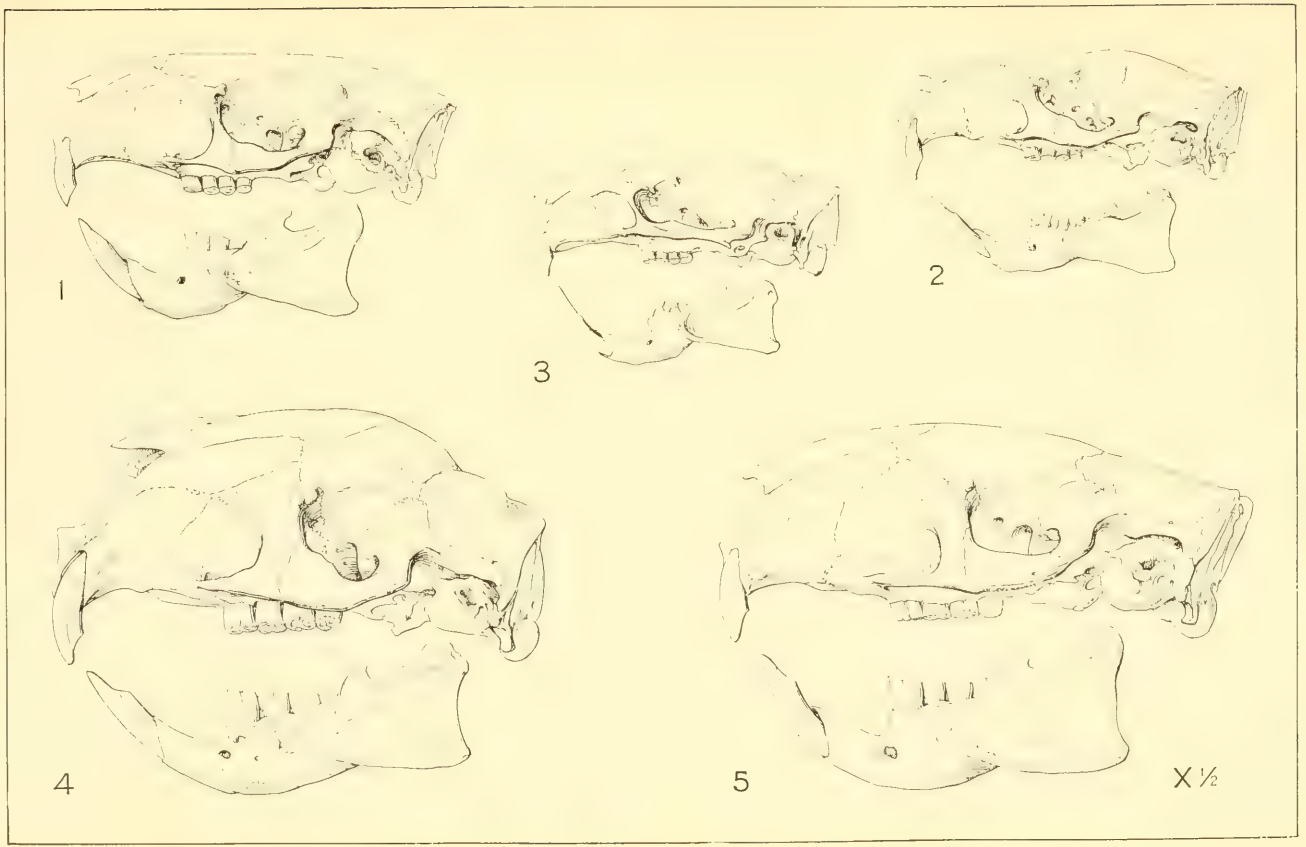
Tail bristles and cervical and lumbar vertebræ of Malayan porcupines. All figures three-fourths natural size.

Fig. 1. Tail bristle of *Acanthion*.
2. Tail bristles of *Thecurus*.
3. Tail bristle of *Atherurus*.
4. Tail bristle of *Trichys*.
5. Axis or second cervical vertebra of *Trichys*.
6. Lumbar vertebra of *Trichys*.
7. Axis or second cervical vertebra of *Atherurus*.
8. Lumbar vertebra of *Atherurus*.
9. Axis or second cervical vertebra of *Thecurus*.
10. Lumbar vertebra of *Thecurus*.
11. Axis or second cervical vertebra of *Acanthion*.
12. Lumbar vertebra of *Acanthion*.



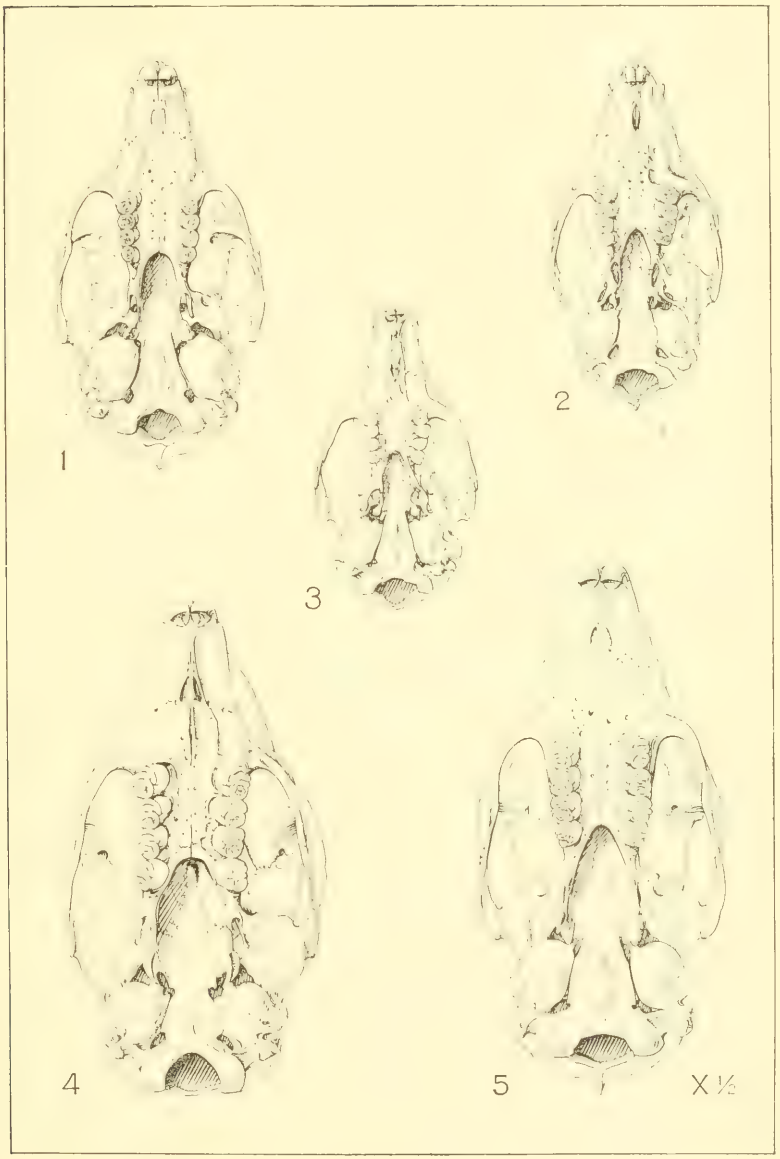
SKULLS OF OLD WORLD PORCUPINES.

FOR EXPLANATION OF PLATE SEE PAGE 594.



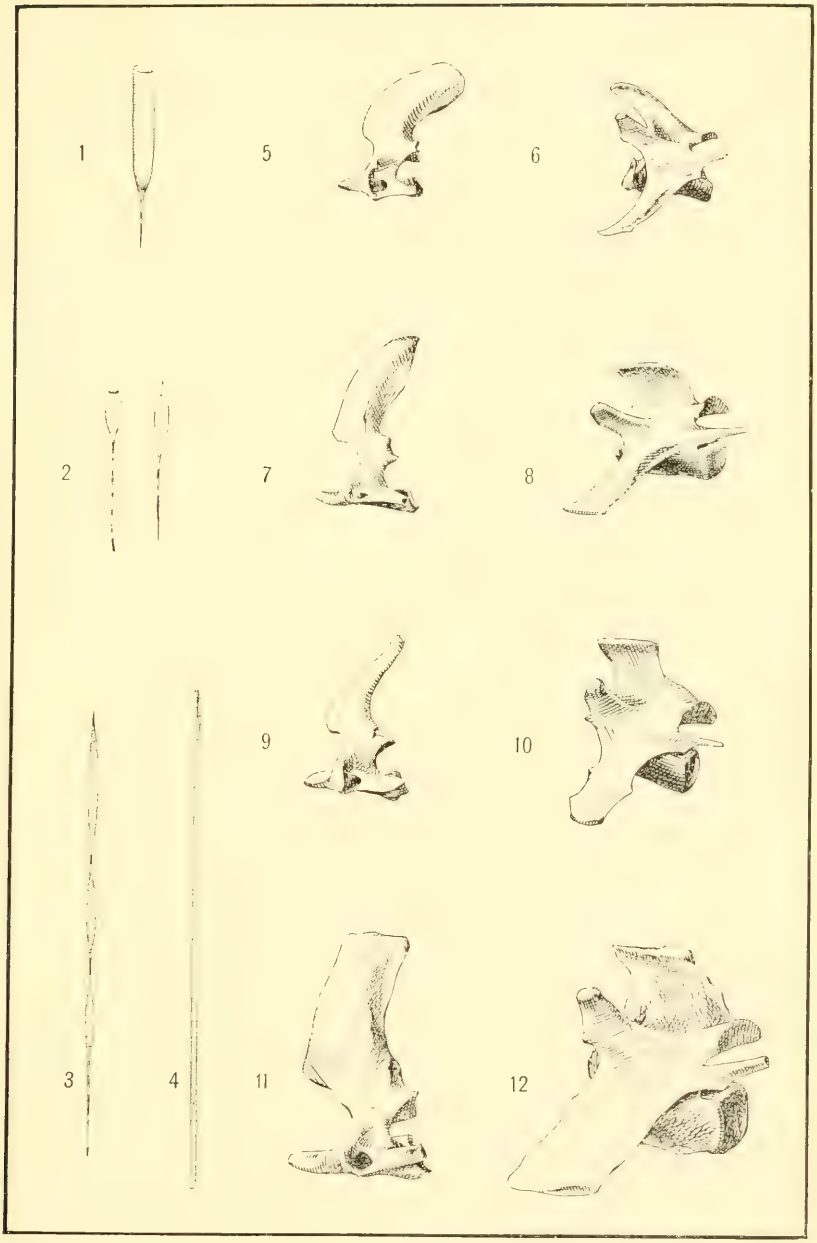
SKULLS OF OLD WORLD PORCUPINES.

FOR EXPLANATION OF PLATE SEE PAGE 594.



SKULLS OF OLD WORLD PORCUPINES.

FOR EXPLANATION OF PLATE SEE PAGE 594.



TAIL BRISTLES AND VERTEBRÆ OF MALAYAN PORCUPINES.

FOR EXPLANATION OF PLATE SEE PAGE 594.

A CATALOGUE OF THE ACARINA, OR MITES, OF THE UNITED STATES.

By Nathan Banks,
Custodian, Section of Arachnida, U. S. National Museum.

INTRODUCTION.

In 1886 Prof. Herbert Osborn and Prof. L. M. Underwood published, in the Canadian Entomologist, a preliminary list of the species of Acarina of North America. It included 99 species in 28 genera. The species described prior to that time were by various entomologists, and in only one case, that of Professor Garman, had a single author done any considerable work in one genus. During the past twenty years several naturalists have described a large number of new species. Professor Wolcott, Doctor Koenike, and Miss Marshall, in the water-mites; Doctor Haller and Professor Tyrrell, in the bird-mites; Professor Neumann, in the ticks; and myself in various families, are chiefly responsible for this increase. At present there are 450 species, grouped in 133 genera, known from the United States; yet this is probably less than a third of our entire acarid fauna.

So little is known regarding the distribution of the species, most of which have been described from the Eastern States, that I have not given localities. In identifying species one must now compare the specimen with descriptions of all the species, irrespective of locality. The generic synonyms are given in the index. In the arrangement of families I have followed the common usage.

It is hoped that by bringing together these references an interest will be stimulated among others that will result in greater work in the Acarina, one of the most important groups from either the biologic or economic standpoint.

A synopsis of the genera of the mites and a list of the literature down to 1904 will be found in a Treatise on the Acarina or Mites, published in the Proceedings, U. S. National Museum, XXVIII, pages 1–114.

CATALOGUE OF THE ACARINA.

Family EUPODIDÆ.

RHAGIDIA.

Rhagida THORELL, Œfv. Svenska Akad. Förh., XXVIII, 1871, p. 700.

R. cavicola BANKS, Amer. Nat., 1897, p. 382.
R. pallida BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 222.

LINOPODES.

Linopodes KOCH, Crust. Myr. Arach. Deutsch., fasc. 4, 1836.

L. antennæpes BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 221.
L. mammouthia BANKS, Amer. Nat., 1897, p. 383.

EUPODES.

Eupodes KOCH, Crust. Myr. Arach. Deutsch., fasc. 4, 1836.

E. marinus BANKS, Trans. Amer. Ent. Soc., XXIII, 1896, p. 75.
E. variabilis BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 221.

NOTOPHALLUS.

Notophallus CANESTRINI, Prosp. Acarof. Ital., II, 1886, p. 202.

N. dorsalis BANKS, Canad. Entom., 1902, p. 172.

TYDEUS.

Tydeus KOCH, Crust. Myr. Arachn. Deutsch., fasc. 4, 1836.

T. gloveri ASHMEAD, Canad. Entom., 1879, p. 159 (*Tyroglyphus*).

Family BDELLIDÆ.

BDELLA.

Bdella LATREILLE, Précis Caract. Ins., 1796, p. 180.

B. borealis KRAMER and NEUMAN, Acariden wahrend Vega Exped., 1883, p. 525.
B. californica BANKS, Proc. Calif. Acad. Science, (3), III, 1904, p. 366.
B. cardinalis BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 219.
B. frigida BANKS, Insects, etc., Commander Isl., 1899, p. 348.
B. marina PACKARD, First Rept. U. S. Fish Com., 1874, p. 544.—BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 220.
B. oblonga SAY, Journ. Phil. Acad., II, 1821, p. 74.—LE CONTE Edit., II, 1859, p. 19.
B. peregrina BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 219.
B. robusta BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 220.
B. tenella BANKS, Trans. Amer. Ent. Soc., XXIII, 1896, p. 75.
B. villosa KRAMER and NEUMAN, Acariden wahrend Vega Exped., 1883, p. 525.

CYTA.

Cyta HEYDEN, Isis, 1826, p. 612.

C. americana BANKS, Canad. Entom., 1902, p. 171 (*Ammonia*).

SCIRUS.

Scirus HERMANN, Mém. Apterol., 1804, p. 62.

S. quadripilis BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 220.

EUPALUS.

Eupalus KOCH, Crust. Myr. Arachn. Deutsch., fasc. 4, 1836.

E. echinatus BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 221.

Family CHEYLETIDÆ.

CHEYLETUS.

Cheyletus LATREILLE, Précis Caract. Ins., 1796, p. 179.

C. clavispinus BANKS, Canad. Entom., 1902, p. 172.
C. ferox BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 134.
C. pyriformis BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 135.
C. seminivorus PACKARD, Guide Study Insects, 1869, p. 665.

MYOBIA.

Myobia HEYDEN, Isis, 1826, p. 613.

M. musculi SCHRANK, Enum. Ins. Austr., 1781, p. 301.—MÉGNIN, Journ. de l'Anat. Phys., XIV, 1878, p. 432.

HARPIRHYNCHUS.

Harpirhynchus MÉGNIN, Journ. de l'Anat. Phys., XIV, 1878, p. 429.

H. longipilus BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 135 (*Sarcopterus*).

PSORERGATES.

Psorergates TYRRELL, Proc. Canad. Inst., (3), I, 1883, p. 342.

P. simplex TYRRELL, Proc. Canad. Inst., (3), I, 1883, p. 342.—NEUMANN, Revue Vetérinaire, April, 1893.—CANESTRINI, Prospetto, VI, 1894, p. 809.

musculinus MICHAEL, Journ. Linn. Soc. Zool., XX, 1889, p. 400 (*Goniomerus*).

SYRINGOPHILUS.

Syringophilus HELLER, Die Schmarotzer * * * den Menschen (Leipzig), 1880, p. 186.

S. bipectinatus HELLER, Die Schmarotzer, 1880, p. 186.—BERLESE, Acari Italiani, fasc. XXXVII, No. 9, 1885, p. 10.

villosa HANCOCK, Amer. Nat., 1895, p. 382 (*Picobia*).

Family ERYTHRÆIDÆ.

ERYTHRÆUS.

Erythræus LATREILLE, Gen. Crust. Ins., I, 1806, p. 146.

E. mamillatus SAY, Journ. Phil. Acad., II, 1821, p. 70.—LECONTE, Edit., II, 1859, p. 16.

E. spinatus BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 210.

ANYSTIS.

Anystis HEYDEN, Isis, 1826, p. 612.

A. agilis BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 211 (*Actineda*).

GEKOBIA.

Gekobia MEGNIN, Ann. Soc. Entom. France, 1878, p. 188.

G. texana BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 134.

Family TETRANYCHIDÆ.

BRYOBIA.

Bryobia KOCH, Crust. Myr. Arachn. Deutsch., fasc. 4, 1836.

B. pratensis GARMAN, Fourteenth Report State Entom. of Illinois, 1885, p. 73.—MARLATT, Insect Life, III, 1890, p. 45.

pallida GARMAN, Insect Life, III, 1890, p. 74 (Young).

B. weyerensis PACKARD, Cave Memoir, 1887, p. 42.

TETRANYCHUS.

Tetranychus DUFOUR, Ann. Sci. Nat., XXV, 1832, p. 276.

T. aceris SHIMER, Trans. Amer. Ent. Soc., II, 1869, p. 320 (*Acarus*).

T. bicolor BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 218; Tech. Bull. no. 8, Div. Ent., U. S. Dept. Agric., 1900, p. 72.

T. bimaculatus HARVEY, Ann. Rept. Maine Agric. Exp. Station, for 1892 (1893), p. 133.—BANKS, Tech. Bull. no. 8, Div. Ent., U. S. Dept. Agric., 1900, p. 73.

T. desertorum BANKS, Tech. Bull. no. 8, Div. Ent., U. S. Dept. Agric., 1900, p. 76.

T. gloveri BANKS, Tech. Bull. no. 8, Div. Ent., U. S. Dept. Agric., 1900, p. 76.—MORGAN, Bull. no. 48, Louisiana Agric. Exp. Sta., 1897, pp. 130–135.—TITUS, Cir. no. 65, U. S. Dept. Agric., Bur. Entom., 1905, p. 5.

T. gracilipes BANKS, Tech. Bull. no. 8, Div. Ent., U. S. Dept. Agric., 1900, p. 72.

T. modestus BANKS, Tech. Bull. no. 8, Div. Ent., U. S. Dept. Agric., 1900, p. 73.

T. mytilaspidis RILEY, Hubbard, Orange Insects, 1885, p. 216.—BANKS, Tech. Bull. no. 8, Div. Ent., U. S. Dept. Agric., 1900, p. 71.—WOODWORTH, Bull. no. 145, California Agric. Exp. Sta., 1902, pp. 19, 5 figs.

T. sexmaculatus RILEY, Insect Life, II, 1890, p. 225.—BANKS, Tech. Bull. no. 8, Div. Ent., U. S. Dept. Agric., 1900, p. 75.

T. telarius LINNÆUS, Fauna Suecia, 1761, p. 481.—BANKS, Tech. Bull. no. 8, Div. Ent., U. S. Dept. Agric., 1900, p. 75.

T. tumidus BANKS, Tech. Bull. no. 8, Div. Ent., U. S. Dept. Agric., 1900, p. 73.

T. verbesinœ COCKERELL, Nature, 16 Oct., 1902, p. 608.

T. viridis BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 218.
T. vitis BOISDUVAL, Entom. Horticole, 1867, p. 92.
telarius MAYET and VIALA, Ann. de l'Ecole Nationale d'Agric. de Montpellier, 1893, pp. 18, 1 pl. (not of Linnæus).

TENUIPALPUS.

Tenuipalpus DONNADIEU, Ann. Sci. Linn., Lyon, XXII, 1875, p. 111.

T. californicus BANKS, Jour. N. Y. Entom. Soc., 1904, p. 55.

TETRANYCHOIDES.

Tetranychoides BANKS, Journ. N. Y. Entom. Soc., 1904, p. 54.

T. californica BANKS, Journ. N. Y. Entom. Soc., 1904, p. 54.

STIGMÆUS.

Stigmæus KOCH, Crust., Myr. Arachn. Deutsch., fasc. 4, 1836.

S. floridanus BANKS, Tech. Bull. no. 8, Div. Ent., U. S. Dept. Agric., 1900, p. 77.

NEOPHYLLOBIUS.

Neophyllobius BERLESE, Acari dann. piante colt., 1886, p. 20.

N. americanus BANKS, Proc. Ent. Soc., Wash., VII, 1906, p. 133.

Family RHYNCHOLOPHIDÆ.

RHYNCHOLOPHUS.

Rhyncholophus DUGÉS, Ann. Sci. Nat., (2), I, 1834, p. 31.

R. angustipes, new name.
gracilipes BANKS, Proc. Calif. Acad. Sci., (3), III, 1904, p. 305 (not of Kramer, 1897).
R. cavernarum PACKARD, Cave Memoir, 1887, p. 42.
R. cinctipes BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 216.
R. elongatus BANKS, Insects, etc., Commander Isl., 1899, p. 348.
R. floridanus BANKS, Trans. Amer. Ent. Soc., XXIII, 1896, p. 74.
R. longipes BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 215.
R. maculatus BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 216.
R. montanus BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 216.
R. parvus BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 216.
R. pilosus BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 217.
R. punctatus BANKS, Proc. Acad. Nat. Sci., Phil., 1904, p. 143.
R. robustus BANKS, Ann. New York Acad. Sci., VIII, 1895, p. 432.
R. roseus BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 215.
R. simplex BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 215.
R. texanus BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 217.

SMARIS.

Smaris LATREILLE, Précis Caract. Ins., 1796, p. 180.

S. australis BANKS, Trans. Amer. Ent. Soc., XXIII, 1896, p. 74.
S. occidentalis BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 214.

Family TROMBIDIIDÆ.

TROMBIDIUM.

Trombidium FABRICIUS, Gen. Insect., 1776, p. 151.

T. armatum KRAMER, and NEUMAN, Acariden wahrend Vega Exped., 1883, p. 521.
T. bulbipes PACKARD, 3rd Mass. Rept., 1873, p. 26.
T. gemmosum BANKS, Proc. Acad. Nat. Sci. Phil., 1901, p. 595.
T. giganteum RILEY, First Rept. U. S. Ent. Com., 1878, p. 312.—BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 212.
T. granulatum BANKS, Canad. Entom., 1902, p. 171.
T. magnificum LE CONTE, Proc. Acad. Nat. Sci. Phil., 1852, p. 145.—BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 213.
T. marinus BANKS, Trans Amer. Ent. Soc., XXIII, 1896, p. 73.
T. scabrum SAY, Journ. Phil. Acad., II, 1821, p. 69.—LE CONTE, Edit., II, 1859, p. 16.—BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 212.
T. sericeum SAY, Jour. Phil. Acad., II, 1821, p. 70.—LE CONTE, Edit., II, 1859, p. 6.—RILEY, 7th Mo. Rept., 1875, p. 175.—BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 212.

MICROTROMBIDIUM.

Microtrombidium HALLER, J. H. Ver. Würtb., XXXVIII, 1882, p. 322.

M. granulosa BANKS, Trans. Amer. Ent. Soc., XXIII, 1896, p. 74 (*Ottonia*).
M. locustarum WALSH, Pract. Entom., I, 1866, p. 126.—RILEY, Amer. Nat., XII, 1878, p. 139; First Ann. Rept. U. S. Ent. Com., 1878, p. 306.—BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 213.
M. muscarum RILEY, First Rept. U. S. Ent. Com., 1878, p. 306.—BANKS, Trans. Amer. Ent. Soc., XXI, 1894, p. 213.
M. trombidiodes BANKS, Trans. Amer. Ent. Soc., XXIII, 1896, p. 74 (*Ottonia*).

Family CÆCULIDÆ.

CÆCULUS.

Cæculus DUFOUR, Ann. Sci. Nat., XXV, 1832, p. 289.

C. americanus BANKS, Proc. Ent. Soc. Wash., IV, 1899, p. 221.
C. clavatus BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 136.

Family HYDRACHNIDÆ.

LIMNOCHARES.

Limnochares LATREILLE, Précis, Caract. Ins., 1796, p. 181.

L. aquaticus LINNÆUS, Faun. Suec., 1761, p. 482.—PIERSIG, Das Tierreich, Lief. 13, 1901, p. 14.

L. extendens SAY, Jour. Phil. Acad., II, 1821, p. 80.—LE CONTE, Edit., II, 1859, p. 22. [Probably not the European species of same name.]

EYLAIS.

Eylais LATREILLE, Précis, Caract. Ins., 1796, p. 182.

E. desecta KOENIKE, Abh. naturw. Ver. Bremen, XIV, 1897, p. 288.

E. falcata KOENIKE, Abh. naturw. Ver. Bremen, XIV, 1897, p. 288.

E. triangulifera KOENIKE, Abh. naturw. Ver. Bremen, XIV, 1897, p. 289.

THYAS.

Thyas KOCH, Crust. Myr. Arach. Deutsch., 1835, fasc. 5.

T. pedunculata KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 192.

T. stolli KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 194.

PANISUS.

Panisus KOENIKE, Zool. Anz., XIX, 1896, p. 356.

P. cataphracta KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 196.

TANAOGNATHUS.

Tanognathus WOLCOTT, Trans. Amer. Micr. Soc., XXI, 1900, p. 193.

T. spinipes WOLCOTT, Trans. Amer. Micr. Soc., XXI, 1900, p. 194.

KRENDOWSKIA.

Krendowskia PIERSIG, Zool. Anz., XVIII, 1895, p. 147.

K. ovata WOLCOTT, Trans. Amer. Micr. Soc., XXI, 1900, p. 181.

STEGANASPIS.

Steganaspis WOLCOTT, Trans. Amer. Micr. Soc., XXII, 1901, p. 105.

S. arrenuroides WOLCOTT, Trans. Amer. Micr. Soc., XXII, 1901, p. 106.

ARRENURUS.

Arrenurus DUGÈS, Ann. Sci. Nat., (2), I, 1834, p. 17.

A. birgei MARSHALL, Trans. Wisc. Acad. Sci., Arts, Lett., XIV (Pt. 1), 1903, p. 158.

A. cardiacus MARSHALL, Trans. Wisc. Acad. Sci., Arts, Let., XIV (Pt. 1), 1903, p. 153.

A. caudatus DE GEER, Mém. Hist. Ins., III, 1778, p. 139.—PIERSIG, Das Tierreich, Lief. 13, 1901, p. 87.—MARSHALL, Trans. Wisc. Acad. Sci., Arts, Lett., XIV (Pt. 2), 1904, p. 521.

A. conicus PIERSIG, Zool. Anzeiger, XVI, 1893, p. 311; Das Tierreich, Lief. 13, 1901, p. 86.—MARSHALL, Trans. Wisc. Acad. Sci., Arts, Lett., XIV (Pt. 1), 1903, p. 158.

A. corniger KOENIKE, Zool. Anzeiger, XVII, 1894, p. 276.—PIERSIG, Das Tierreich, Lief. 13, 1901, p. 84.—MARSHALL, Trans. Wisc. Acad. Sci., Arts, Lett., XIV (Pt. 1), 1903, p. 155.

A. cylindratus PIERSIG, Zool. Anzeiger, XIX, 1896, p. 441; Das Tierreich, Lief. 13, 1901, p. 84.—MARSHALL, Trans. Wisc. Acad. Sci., Arts, Lett., XIV (Pt. 1), 1903, p. 156.

A. globator MÜLLER, Zool. Dan. Prodr., 1776, p. 188.—PIERSIG, Das Tierreich, Lief. 13, 1901, p. 82.—MARSHALL, Trans. Wisc. Acad. Sci., Arts, Lett., XIV (Pt. 1), 1903, p. 148.

A. globator var. megalurus MARSHALL, Trans. Wisc. Acad. Sci., Arts, Lett., XIV (Pt. 1), 1903, p. 150.

A. interpositus KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 176.

A. krameri KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 182.

A. lautus KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 172.

A. manubriator MARSHALL, Trans. Wisc. Acad. Sci., Arts, Lett., XIV (Pt. 1), 1903, p. 151.

A. morrisoni MARSHALL, Trans. Wisc. Acad. Sci., Arts, Lett., XIV (Pt. 2), 1904, p. 523.

A. parallellatus MARSHALL, Trans. Wisc. Acad. Sci., Arts, Lett., XIV (Pt. 1), 1903, p. 154.

A. securiformis PIERSIG, Zool. Anzeiger, XVII, 1894, p. 377; Das Tierreich, Lief. 13, 1901, p. 83.—MARSHALL, Trans. Wisc. Acad. Sci., Arts, Lett., XIV (Pt. 1), 1903, p. 152.

A. setiger KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 178.

ATURUS.

Aturus KRAMER, Arch. f. Naturgesch, XLI, 1875, p. 309.

A. mirabilis PIERSIG, Sitzungsb. Ges. Leipzig, XXII–XXIII, 1897, p. 157.
scaber KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 186 (not Kramer).

XYSTONOTUS.

Xystonotus WOLCOTT, Trans. Amer. Micr. Soc., XXI, 1900, p. 185.

X. asper WOLCOTT, Trans. Amer. Micr. Soc., XXI, 1900, p. 186.

MIDEOPSIS.

Mideopis NEUMAN, Svenska Akad. Handl., XVII, 1880, p. 67.

M. orbicularis MÜLLER, Zool. Dan. Prodr., 1776, p. 190.—KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 191.

LEBERTIA.

Lebertia NEUMAN, Svenska Akd. Handl., XVII, 1880, p. 68.

L. tau-insignita LEBERT, Bull. Soc. Vaudoise (2), XVI, 1879, p. 371.—KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 201.

SPERCHON.

Sperchon KRAMER, Arch. f. Naturgesch., 1877, p. 240.

S. glandulosus, KOENIKE, Zeitschr. wiss. Zool., XLIII, 1885, p. 270; Abh. naturw. Ver. Bremen, XIII, 1895, p. 202.
S. parmatus KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 202.
S. tenuipalpis KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 204.

LIMNESIA.

Limnesia KOCH, Crust. Myr. Arach. Deutsch., fasc. 2, 1835.

L. cornuta WOLCOTT, Trans. Amer. Micr. Soc., XXIV., 1903, p. 143.
L. histrionica HERMANN, Mém. Apterol., 1804, p. 55.—WOLCOTT, Trans. Amer. Micr. Soc., XXIV, 1903, p. 146.
L. koenikei PIERSIG, Zool. Anz., 1894, p. 115; Das Tierreich, XIII, 1901, p. 177.
L. maculata MÜLLER, Zool. Danica prod., 1776, p. 191.—WOLCOTT, Trans. Amer. Micr. Soc., XXIV, 1903, p. 156.
L. paucispina WOLCOTT, Trans. Amer. Micr. Soc., XXIV, 1903, p. 152.
L. undulata MÜLLER, Hydrachnæ Daniæ, 1781, p. 80.—KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 206.—WOLCOTT, Trans. Amer. Micr. Soc., XXIV, 1903, p. 149.

LIMNESIOPSIS.

Limnesiopsis PIERSIG, Zoologica, XXII, 1897, p. 204.

L. anomala KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 207.

KOENIKEA.

Koenikea WOLCOTT, Trans. Amer. Micr. Soc., XXI, 1900, p. 189.

K. concava WOLCOTT, Trans. Amer. Micr. Soc., XXI, 1900, p. 190.

ATRACTIDES.

Atractides KOCH, Crust. Myr. Arach. Deutsch., fasc. 11, 1837.

A. spinipes KOCH, Crust. Myr. Arach. Deutsch., fasc. 11, 1837, fig. 16.
ovalis KOENIKE, Abh. naturw. Ver. Bremen, VIII, 1883, p. 32; XIII, 1895, p. 211.

HYGROBATES.

Hygrobates KOCH, Crust. Myr. Arach. Deutsch., fasc. 10, 1837.

H. decaporus KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 215.
H. exilis KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 213.
H. longipalpis HERMANN, Mém. Apterol., 1804, p. 55.—KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 212.
H. multiporus KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 216.

TYRRELLIA.

Tyrrellia KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 198.

T. circularis KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 199.

ATAX.

Atax FABRICIUS, Syst. Antliatorum, 1805, p. 366.

A. abnormipes WOLCOTT, Zool. Bull., I, 1898, p. 280; Trans. Amer. Micr. Soc., XX, 1899, p. 218.
A. aculeatus KOENIKE, Zool. Anz., XIII, 1890, p. 140.
A. aculeatus var. sayi PIERSIG, Das Tierreich, XIII, 1901, p. 213.—WOLCOTT, Trans. Amer. Micr. Soc., XX, 1899, p. 210.
A. adensameri THON, Ann. Hofmus. Wien, XVI, 1902, p. 31.
A. arcuata WOLCOTT, Zool. Bull., I, 1898, p. 284; Trans. Amer. Micr. Soc., XX, 1899, p. 231.
A. crassipes MÜLLER, Zool. Dan. Prodr., 1776, p. 189.—WOLCOTT, Trans. Amer. Micr. Soc., XX, 1899, p. 205.
A. fossulatus KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 221.—WOLCOTT, Trans. Amer. Micr. Soc., XX, 1899, p. 226.
A. indistinctus WOLCOTT, Zool. Bull., I, 1898, p. 281; Trans. Amer. Micr. Soc., XX, 1899, p. 221.
A. intermedius KOENIKE, Abh. naturw. Ver. Bremen, VII, 1882, p. 265.
A. intermedius var. Wolcotti PIERSIG, Zool. Anzeiger, XXIII, 1900, p. 211.—WOLCOTT, Trans. Amer. Micr. Soc., XX, 1899, p. 214.
A. pectinata WOLCOTT, Zool. Bull., I, 1898, p. 280; Trans. Amer. Micr. Soc., XX, 1899, p. 212.
A. serratus WOLCOTT, Zool. Bull., I, 1898, p. 282; Trans. Amer. Micr. Soc., XX, 1899, p. 223.
A. stricta WOLCOTT, Zool. Bull., I, 1898, p. 283; Trans. Amer. Micr. Soc., XX, 1899, p. 229.
A. tumidus WOLCOTT, Zool. Bull., I, 1898, p. 285; Trans. Amer. Micr. Soc., XX, 1899, p. 236.
A. ypsilophorus BONZ, Nova Acta Acad. Leop., VII, 1783, p. 52.
A. ypsilophorus var. haldemani PIERSIG, Zool. Anz., XXIII (1900), p. 212.—KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 217.—WOLCOTT, Trans. Amer. Micr. Soc., XX, 1899, p. 233.
formosa DANA and WHELPLEY, Amer. Jour. Sci., XXX, 1836, p. 357.
oviformis HALDEMAN, Zool. Contrib., 1842, p. 1.
lactea HALDEMAN, Zool. Contrib., 1842, p. 1.

UNIONICOLA.

Unionicola HALDEMAN, Zool. Contrib., 1842, p. 1. [Most, if not all, the species are probably synonyms of *Atax ypsilophorus*.]

U. humerosa HALDEMAN, Zool. Contrib., 1842, p. 2.
U. lugubris HALDEMAN, Zool. Contrib., 1842, p. 2.
U. personata HALDEMAN, Zool. Contrib., 1842, p. 2.
U. proxima HALDEMAN, Zool. Contrib., 1842, p. 2.
U. reticulata HALDEMAN, Zool. Contrib., 1842, p. 3.
U. symmetrica HALDEMAN, Zool. Contrib., 1842, p. 2.
U. unicolor HALDEMAN, Zool. Contrib., 1842, p. 3.

NEUMANIA.

Neumania LEBERT, Bull. Soc. Vaudoise (2), XVI, 1879, p. 340.

N. vernalis MÜLLER, Zool. Dan. Prodr., 1776, p. 189.—KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 218.—PIERSIG, Das Tierriech, XIII, 1901, p. 227.

NAJADICOLA.

Najadicola PIERSIG, Zool. Anz., XX, 1897, p. 60.

N. ingens KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 219.—WOLCOTT, Trans. Amer. Micr. Soc., XX, 1899, p. 238.

FELTRIA.

Feltria KOENIKE, Zool. Anz., XV, 1892, p. 323.

F. minuta KOENIKE, Zool. Anz., p. 323, 1892.—PIERSIG, Das Tierreich, XIII, 1901, p. 231.

PIONA.

Piona KOCH, Ubers. Arachn. Syst., III, 1842, p. 13.

P. constrictus WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 222.
P. coronis WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 208.
P. crassus WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 246.
P. debilis WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 234.
P. exilis WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 210.
P. fuscatus HERMANN, Mem. apterol., 1804, p. 58.—PIERSIG, Das Tierreich, XIII, 1901, p. 256.
P. guatemalensis STOLL, Biol. Cent.-Amer. Arach.-Acari., 1887, p. 11.—KOENIKE, Abh. naturw. Ver. Bremen, XIII, 1895, p. 209.
P. inconstans WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 241.
P. medius WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 229.
P. obturbans PIERSIG, Zool. Anz., XIX, 1896, p. 439.—WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 240.
P. pugilis WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 213.
P. reighardi WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 235.
P. rotundus KRAMER, Arch. f. Naturgesch., 1879, p. 12.—WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 231.
P. setiger WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 243.
P. spinulosus WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 226.
P. triangularis WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 220.
P. turgidus WOLCOTT, Trans. Amer. Micr. Soc., XXIII, 1902, p. 216.

HYDRACHNA.

(Unplaced.)

H. belostomæ RILEY, 1st Rept. U. S. Ent. Com., 1878, p. 312.
H. coccinea HALDEMAN, Proc. Phil. Acad., I, 1842, p. 196.
H. nebulosa HALDEMAN, Proc. Phil. Acad., I, 1842, p. 196.
H. pyriformis DANA and WHELPLEY, Amer. Journ. Sci., XXX, 1836, p. 358.
H. 5-undata HALDEMAN, Proc. Phil. Acad., I, 1842, p. 184.
H. scabra HALDEMAN, Proc. Phil. Acad., I, 1842, p. 184.
H. triangularis SAY, Journ. Phil. Acad., II, 1821, p. 79.—LE CONTE, Edit., II, 1859, p. 22. [Probably equal *Atax ypsilophorus*.]
H. tricolor PACKARD, Amer. Journ. Sci. (3), I, 1871, p. 108.

Family HALACARIDÆ.

THALASSARACHNA.

Thalassarachna PACKARD, Amer. Journ. Sci. (3), I, 1871, p. 108.

T. verrillii PACKARD, Amer. Journ. Sci. (3), I, 1871, p. 107.

Family IXODIDÆ.

ARGAS.

Argas LATREILLE, Précis Caract. Ins., 1796, p. 178.

A. miniatus KOCH, Arch. f. Naturg., X, 1844, p. 219.—SALMON and STILES, 17th Ann. Rept. Bur. Anim. Ind., 1902, p. 402.

americana PACKARD, Rept. U. S. Geol. Survey Montana, Idaho, Wyoming, Utah, 1872, p. 740.—NEUMANN, Mém. Soc. Zool. France, 1896, p. 9.

radiatus RAILLIET, Traité Zool. Méd., 1893, p. 718.

persicus NEUMANN, Arch. Parasit., IX, 1905, p. 240 (not of Fischer).

A. sanchezi DUGÈS, La Naturaleza (2), I, 1891, p. 20.—NEUMANN, Mém. Soc. Zool. France, 1896, p. 16; 1901, p. 255.

ORNITHODOROS.

Ornithodoros KOCH, Arch. f. Naturg., X, 1844, p. 219.

O. megnini DUGÈS, La Naturaleza Mexicana, VI, 1885, p. 197.—NEUMANN, Mém. Soc. Zool. France, 1896, p. 42.—SALMON and STILES, 17th Ann. Rept. Bur. Anim. Ind., 1902, p. 408.

spinosum MARX, Proc. Ent. Soc. Washington, III, 1895, p. 199 (*Rhynchoprium*).

O. turicata DUGÈS, La Natur. Mexicana, VI, 1885, p. 196.—NEUMANN, Mém. Soc. Zool. France, 1896, p. 31.

americanus MARX, Proc. Ent. Soc. Washington, 1895, III, p. 199.

IXODES.

Ixodes LATREILLE, Précis Caract. Ins., 1796, p. 179.

I. angustus NEUMANN, Mém. Soc. Zool. France, 1889, p. 136; 1901, p. 284.

I. arcticus OSBORN, Fur Seals and Fur Seal Islands of North Pacific Ocean, III, 1899, pp. 553–554.

I. brunneus KOCH, Arch. f. Naturg., X, 1844, p. 232; Arachn. Syst., IV, 1847, p. 101; NEUMANN, Arch. Parasit., VIII, 1904, p. 454.

I. californicus BANKS, Proc. California Acad. Science (3), III, 1904, p. 369.

I. cookei PACKARD, 1st Ann. Rept. Peabody Acad. Science, 1869, p. 67.

cruciarius FITCH, 14th New York Rept., 1871, p. 366.

hexagonus var. *longispinosus* NEUMANN, Mém. Soc. Zool. France, 1901, p. 283.

hexagonus SALMON and STILES, 17th Ann. Rept. Bur. Anim. Ind., 1902, p. 467 (not of Leach).

I. dentatus NEUMANN, Mém. Soc. Zool. France, 1899, p. 119.

I. diversifossus NEUMANN, Mém. Soc. Zool. France, 1899, p. 136.

I. frontalis PANZER, Fauna Ins. Germ., fasc. 59, fig. 23, 1795.—NEUMANN, Mém. Soc. Zool. France, 1899, p. 133.

I. fuscus SAY, Journ. Phil. Acad., II, 1821, p. 79.—LE CONTE, Edit., II, 22, 1859. [Probably male of *I. scapularis.*]

I. inchoatus NEUMANN, Mém. Soc. Zool. France, 1901, p. 283 (as var. of *hexagonus*). [Doubtfully the same as European.]

I. ricinus LINNAEUS, Syst. Nat., 1758, p. 615.—NEUMANN, Mém. Soc. Zool. France, 1899, p. 112.—SALMON and STILES, 17th Ann. Rept. Bur. Anim. Ind., 1902, p. 463.

I. scapularis SAY, Journ. Phil. Acad., II, 1821, p. 78.—LE CONTE, Edit., II, 1859, p. 21.

affinis NEUMANN, Mém. Soc. Zool. France, 1899, p. 120.

I. sculptus NEUMANN, Arch. Parasit., VIII, 1904, p. 462.

I. uriæ WHITE, Sutherland's Journ. Voy. Baffins Bay, II, App., 1852, p. cex. [No description.] [Perhaps *Ceratixodes borealis* Kramer and Neuman.]

CERATIXODES.

Ceratixodes NEUMANN, Arch. Parasit., VI, 1902, p. 115.

C. borealis KRAMER and NEUMAN, Acariden wahrend Vega Exped., 1883, p. 526.

fimbriatus KRAMER and NEUMAN, Acariden wahrend Vega Exped., 1883, p. 526, male.

hirsutus BIRULA, Bull. Acad. Imp. St. Petersb., 1895, p. 356.

C. signatus BIRULA, Bull. Acad. Imp. St. Petersb., 1895, p. 357.

HÆMAPHYSALIS.

Hæmaphysalis KOCH, Arch. f. Naturg., X, 1844, p. 237.

H. chordeilis PACKARD, 1st Ann. Rept. Peabody Acad. Science, 1869, p. 67.

H. leporis-palustris PACKARD, 1st Ann. Rept. Peabody Acad. Science, 1869, p. 67.—NEUMANN, Mém. Soc. Zool. France, 1897, p. 343.

rostralis DUGES, Bull. Soc. Zool. France, 1888, p. 129. (*Gonixodes.*)

AMBLYOMMA.

Amblyomma KOCH, Arch. f. Naturg., X, 1844, p. 223.

A. americana LINNAEUS, Syst. Nat., X, 1758, p. 615.—FITCH, 14th N. Y. Rept., 1871, p. 364.—NEUMANN, Mém. Soc. Zool. France, 1899, p. 209.—SALMON and STILES, 17th Ann. Rept. Bur. Anim. Ind., 1902, p. 475.

? orbiculatus SAY, Journ. Phil. Acad., II, 1821, p. 76.

unipuncta PACKARD, 1st Ann. Rept. Peabody Acad. Sci., 1869, p. 66.

A. cajennense FABRICIUS, Entom. syst., IV, 1794, p. 427.—KOCH, Übersicht Arachn. syst., IV, 1847, p. 73.—NEUMANN, Mém. Soc. Zool. France, 1899, p. 205.

crenatum SAY, Journ. Phil. Acad., II, 1821, p. 76.—LE CONTE, Edit., II, 1859, p. 20.

mixtum KOCH, Arch. f. Naturg., X, 1844, p. 227.

A. maculatum KOCH, Arch. f. Naturg., X, 1844, p. 227.—NEUMANN, Mém. Soc. Zool., France, 1899, p. 249.

tigrinum KOCH, Arch. f. Naturg., X, 1844, p. 227.

tenellum KOCH, Arch. f. Naturg., X, 1844, p. 227.

rubripes KOCH, Arch. f. Naturg., X, 1844, p. 228.

ovatum KOCH, Arch. f. Naturg., X, 1844, p. 228.

triste KOCH, Arch. f. Naturg., X, 1844, p. 229.

A. tuberculatum MARX, Insect Life, VI, p. 314.—NEUMANN, Mém. Soc. Zool. France, 1899, p. 235.

DERMACENTOR.

Dermacentor KOCH, Arch. f. Naturges., X, 1844, p. 235.

D. albipictus PACKARD, Amer. Nat., II, 1868, p. 559 (no description); Guide Study Ins., 9th part, p. 662, 1869 (Aug.); Amer. Nat., III, 1869, p. 365–6.

variegatus NEUMANN, Mém. Soc. Zool. France, 1897, p. 367.—SALMON and STILES, 17th Ann. Rept. Bur. Anim. Ind., 1902, p. 452.

reticulatus SALMON and STILES, 17th Ann. Rept. Bur. Anim. Ind., 1902, p. 448 (not of Fabricius).

D. bifurcatus NEUMANN, Mém. Soc. Zool. France, 1899, p. 122; Arch. Parasitol., VIII, 1904, p. 453.

D. nigrolineatus PACKARD, 1st Ann. Rept. Peabody Acad. Science, 1869, p. 66.

D. nitens NEUMANN, Mém. Soc. Zool. France, 1897, p. 376.—SALMON and STILES, 17th Ann. Rept. Bur. Anim. Ind., 1902, p. 455.

D. occidentalis NEUMANN, Archiv. Parasitol., IX, 1905, p. 235.

reticulatus NEUMANN, Mém. Soc. Zool. France, 1897, p. 360, part.

D. parumapertus NEUMANN, Mém. Soc. Zool. France, 1901, p. 267; Archiv. Parasitol., IX, 1905, p. 236.

D. variabilis SAY, Journ. Phil. Acad., II, 1821, p. 77.—LE CONTE, Edit., II, 1859, p. 21.

americanus AUTHORS (not Linnaeus).

electus KOCH, Arch. f. Naturges., X, 1844, p. 235.—SALMON and STILES, 17th Ann. Rept. Bur. Anim. Ind., 1902, p. 455.

albipictus PACKARD, 1st Rept. Peabody Acad. Sci., 1869, p. 66 (not of Guide and Amer. Nat.).

5-striatus FITCH, 14th New York Rept., 1871, p. 366.

robertsoni FITCH, 14th New York Rept., 1871, p. 366.

? punctulatus SAY, Journ. Phil. Acad., II, 1821, p. 78.—LE CONTE, Edit., p. 21, 1859.

MARGAROPUS.

Margaropus KARSCH, Mitt. Münch. Ent. Ver., 1879, p. 96.

M. annulatus SAY, Journ. Phil. Acad., II, 1821, p. 75.—LE CONTE, Edit., II, 1859, p. 19.—NEUMANN, Mém. Soc. Zool. France, 1897, p. 407.—SALMON and STILES, 17th Ann. Rept. Bur. Anim. Industry, 1902, p. 420.

bovis PACKARD, 1st Rept. Peabody Acad. Sci., 1869, p. 68.

bovis RILEY, Gamgee's Rept. Diseases Cattle, 1869, p. 168.

indentatus GAMGEE, Gamgee's Rept. Diseases Cattle, 1869, p. 121.

dugesi MÉGNIN, Les Parasites, 1880, p. 126.

IXODES.

(Unplaced.)

I. cinctus FABRICIUS, Syst. Antliatorum, 1805, p. 356.

I. erraticus SAY, Journ. Phil. Acad., 1821, p. 77.—LE CONTE, Edit., II, 1859, p. 20. [Probably a *Dermacentor*.]

Family GAMASIDÆ.

HALARACHNE.

Halarachne ALLMAN, Ann. Mag. Nat. Hist., XX, 1847, p. 47.

H. americana BANKS, Proc. Ent. Soc. Wash., IV, 1899, p. 213.

PTEROPTUS.

Pteroptus DUFOUR, Ann. Sci. Nat., XXVI, 1832, p. 98.

P. americanus BANKS, Canad. Entom., 1902, p. 173.

DERMANYSSUS.

Dermanyssus DUGES, Ann. Sci. Nat. (Zool.), I, 1834, p. 18.

D. gallinæ REDI, Esper. Int. Insetti., 1668, pl. II.—MÉGNIN, Parasit., 1880, p. 115.—OSBORN, Bull. 33 Iowa Agric. Exp. Sta., 1896, p. 595.

LIPONYSSUS.

Liponyssus KOLENATI, Sitzungsber. Kais. Akad. Wissenschft. Wien, Math.-naturw. cl., XXXV, 1859, p. 172.

L. americanus BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 136.

HÆMOGAMASUS.

Hæmogamasus BERLESE, Acari Myr. Scorp., fasc. 52, 1889.

H. americanus BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 137.

RAILLIETIA.

Raillietia TROUESSART, C. R. Soc. Biol., LIV, 1902, p. 1337; Bull. Soc. Zool. France, XXVII, 1902, p. 232.

R. auris LEIDY, Proc. Phil. Acad., 1872, p. 138.—TROUESSART, C. R. Soc. Biol., LIV, 1902, p. 1337; Bull. Soc. Zool. France, XXVII, 1902, p. 233.

CELÆNOPSIS.

Celænopsis BERLESE, Acari Myr. Scorp., fasc. 31, 1886.

C. americanus BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 137.

SEIUS.

Seius KOCH, Crust. Myr. Arachn. Deutsch., fasc. 4, 1836.

S. sanborni PACKARD, Cave Memoir, 1887, p. 42.
S. quadripilis BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 138.

LÆLAPS.

Lælaps KOCH, Crust. Myr. Arachn. Deutsch., fasc. 4, 1836.

L. cavernicola PACKARD, Cave Memoir, 1887, p. 42.
L. cuneifer var. americanus BERLESE, Redia, I, 1904, p. 418.
L. macropilis BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 139.
L. pilosula BANKS, Proc. Calif. Acad. Science, (3), III, 1904, p. 368.
L. placidus BANKS, Journ. N. Y. Ent. Soc., 1895, p. 128.
L. similis MONIEZ, Rev. Biol. Nord France, VI, 1894, p. 20.
L. wyandottensis PACKARD, Cave Memoir, 1887, p. 42.

ECHINOMEGISTUS.

Echinomegistus BERLESE, Redia, I, 1904, p. 266.

E. wheeleri WASMANN, Zool. Anzeiger, 1902, p. 72 (*Antennophorus*).—BERLESE, Redia, I, 1904, p. 398.

GAMASUS.

Gamasus LATREILLE, Hist. nat. Crust. Ins., III, 1802, p. 64.

G. antennæpes SAY, Journ. Phil. Acad., II, 1821, p. 71.—LE CONTE, Edit., II, 1859, p. 17.
G. californicus BANKS, Proc. Calif. Acad. Science (3), III, 1904, p. 368.
G. juloides SAY, Journ. Phil. Acad., II, 1821, p. 72.—LE CONTE, Edit., II, 1859, p. 18.
G. longipalpoides FELT, 11th Rept. State Entom. N. Y., 1896, p. 259. [Name not to be applied unless mite is new.]
G. musculus SAY, Journ. Phil. Acad., II, 1821, p. 72.—LE CONTE, Edit., II, 1859, p. 17.
G. nidularius SAY, Journ. Phil. Acad., II, 1821, p. 72.—LE CONTE, Edit., II, 1859, p. 17.
G. passali GUÉRIN, Iconog. Règne Anim., IV, Arachn., 1843, p. 15.
G. spinipes SAY, Journ. Phil. Acad., II, 1821, p. 71.—LE CONTE, Edit., II, 1859, p. 17.
G. stygius PACKARD, Cave Memoir, 1887, p. 42.
G. troglodytes PACKARD, Cave Memoir, 1887, p. 42.

MACROCHELES.

Macrocheles LATREILLE, Règne Anim. (nouv. ed. rev. et aug.), IV, 1829, p. 282.

M. arcticus KRAMER and NEUMAN, Acariden wahrend Vega Exped., 1883, p. 522.
M. carolinensis BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 137.
M. exilis BANKS, Proc. Wash. Acad. Sciences, II, 1900, p. 485.
M. mœstus BANKS, Canad. Entom., 1898, p. 265.

MEGISTHANUS.

Megisthanus THORELL, Ann. Mus. Genov., XVIII, 1882, p. 41.

M. floridanus BANKS, Proc. Acad. Nat. Sci. Phil., 1904, p. 145.

LIROASPIS.

Liroaspis BANKS, Canad. Entom., 1902, p. 174.

L. americana BANKS, Canad. Entom., 1902, p. 174.

UROPODA.

Uropoda LATREILLE, Gen. Crust. Ins., I, 1806, p. 157.

U. americana RILEY, Proc. Am. Assoc. Adv. Sci., XXV, 1877, p. 273; 9th Mo. Rept., 1877, p. 41.
U. campomolendina var. **canadensis** BERLESE, Redia, II, 1905, p. 22.
U. formica FITCH, Trans. N. Y. State Agric. Soc. for 1854, p. 857, (1855). 1st Rept., p. 153.
U. lucifugus PACKARD, Cave Memoir, 1887, p. 42.
U. pennsylvanica BERLESE, Redia, I, 1904, p. 251; p. 347 (*Uroplitella*).
U. punctulata BANKS, Canad. Entom., 1898, p. 266.

TRACHYTES.

Trachytes MICHAEL, Trans. Roy. Micr. Soc., 1894, p. 297.

T. lagenæformis BERLESE, Redia, II, 1905, p. 21.

CILLIBA.

Cilliba HEYDEN, Isis, 1826, p. 612.

C. circularis BANKS, Canad. Entom., 1898, p. 266 (*Discopoma*).
C. hirsuta BANKS, Proc. U. S. Nat. Mus., XXV, 1902, p. 221 (*Discopoma*).
C. hirticoma BERLESE, Redia, I, 1904, pp. 246, 331.

DINYCHUS.

Dinychus KRAMER, Arch. f. Naturg., LII, 1886, p. 255.

D. americanus BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 139.

Family ORIBATIDÆ.

GALUMNA.

Galumna HEYDEN, Isis, 1826, p. 612. [*Oribata* of authors, not of Latreille.]

G. affinis BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 6.
G. alata PACKARD, Cave Memoir, 1887, p. 42. [Name preoccupied; but it may be a synonym of some other species.]
G. arborea BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 7.
G. armipes BANKS, Proc. Acad. Nat. Sci. Philad., 1906, p. 492.
G. depressa BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 6.
G. emarginata BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 7.
G. hirsuta BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 7.
G. imperfecta BANKS, Proc. Acad. Nat. Sci. Philad., 1906, p. 492.
G. magna BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 6.
G. minuscula BANKS, Proc. Acad. Nat. Sci. Philad., 1906, p. 492.
G. mœsta BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 6.

G. nitidula BANKS, Proc. Acad. Nat. Sci. Philad., 1906, p. 491.
G. palustris BANKS, Journ. N. Y. Ent. Soc., 1895, p. 128.
G. persimilis BANKS, Proc. Acad. Nat. Sci. Philad., 1906, p. 491.
G. pratensis BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 6.
G. robusta BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 7.
G. slossonæ BANKS, Proc. Acad. Nat Sci. Philad., 1906, p. 490.
G. texana BANKS, Proc. Acad. Nat. Sci., Philad., 1906, p. 494
G. turgida BANKS, Proc. Acad. Nat. Sci. Philad., 1906, p. 493.
G. unimaculata BANKS, Proc. Acad. Nat. Sci. Philad., 1906, p. 490.
G. virginica BANKS, Proc. Acad. Nat. Sci. Philad., 1906, p. 493.

ORIBATELLA.

Oribatella BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 8.

O. aquatica BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 9.
O. armata BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 9.
O. bidentata BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 8.
O. borealis BANKS, Insects, etc., Commander Isl., 1899, p. 349.
O. minuta BANKS, Trans. Amer. Ent. Soc., XXIII, 1896, p. 76.
O. obesa BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 9.
O. perfecta BANKS, Trans. Amer. Ent. Soc., XXIII, 1896, p. 75.
O. 4-dentata BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 8.
O. setosa BANKS, Journ. N. Y. Ent. Soc., 1895, p. 129.
O. signata BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 9.

ORIBATODES.

Oribatodes BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 10.

O. mirabilis BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 10.

GYMNOBATES.

Gymnobates BANKS, Canad. Entom., 1902, p. 175.

G. glaber BANKS, Canad. Entom., 1902, p. 176.

ORIBATULA.

Oribatula BERLESE, Acari, Myriop. Scorp. Ital., Crypt., II, 1896, p. 54.

O. pallida BANKS, Proc. Acad. Nat. Sci. Philad., 1906, p. 494.

EREMÆUS.

Eremæus KOCH, Crust. Myr. Arach. Deutsch., fasc. 3, 1835.

E. arctica BANKS, Insects, etc., Commander Isl., 1899, p. 349.
E. floridanus BANKS, Proc. Acad. Nat. Sci. Philad., 1904, p. 145.
E. pilosus BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 11.

LIACARUS.

Liacarus Michael, Das Tierreich, III, 1898, p. 40.

L. abdominalis Banks, Proc. Acad. Nat. Sci. Philad., 1906, p. 495.
L. carolinensis Banks, Proc. Acad. Nat. Sci. Philad., 1906, p. 494.
L. concolor Banks, Trans. Amer. Ent. Soc., XXII, 1895, p. 11.
L. frontalis Banks, Proc. Acad. Nat. Sci. Philad., 1906, p. 495.
L. modestus Banks, Proc. California Acad. Science (3), III, 1904, p. 367.
L. nitidus Banks, Trans. Amer. Ent. Soc., XXII, 1895, p. 10.

TEGEOCRANUS.

Tegeocranus Nicolet, Arch. Mus., Paris, VII, 1855, p. 464.

T. lamellatus Banks, Proc. Acad. Nat. Sci. Philad., 1906, p. 497.

OPPIA.

Oppia Koch, Übers. Arachn. Syst., III, 1842, p. 104.

O. canadensis Banks, Proc. Acad. Nat. Sci. Philad., 1906, p. 497.
O. montana Banks, Proc. Acad. Nat Sci. Philad., 1906, p. 497.
O. spinipes Banks, Proc. Acad. Nat. Sci. Philad., 1906, 496.

NOTASPIS.

Notaspis Hermann, Mém. Apterol., 1804, p. 87.

N. carbonarius Banks, Proc. Acad. Nat. Sci. Philad., 1906, p. 496.
N. castaneus Banks, Proc. Acad. Nat. Sci. Philad., 1906, p. 496.
N. punctulatus Banks, Trans. Amer. Ent. Soc., XXII, 1895, p. 10.

ORIBATA.

Oribata Latreille, Hist. Nat. Crust. Ins., III, 1802, p. 65.

O. angustipes Banks, Proc. Ent. Soc. Wash., VII, 1906, p. 136.
O. australis Banks, Trans. Amer. Ent. Soc., XXII, 1895, p. 12.
O. bulbipedata Packard, Cave Memoir, 1887, p. 42.
O. californica Banks, Proc. California Acad. Science (3), 1904, p. 367.
O. floridana Banks, Trans. Amer. Ent. Soc., XXIII, 1896, p. 76.
O. longiseta Banks, Proc. Acad. Nat. Sci. Philad., 1906, p. 498.
O. minuta Banks, Trans. Amer. Ent. Soc., XXII, 1895, p. 12.
O. puritanica Banks, Proc. Acad. Nat. Sci. Philad., 1906, p. 498.

CARABODES.

Carabodes Koch, Crust. Myr. Arach. Deutsch., fasc. 3, 1835.

C. apicalis Banks, Trans. Amer. Ent. Soc., XXII, 1895, p. 13.
C. brevis Banks, Trans. Amer. Ent. Soc., XXIII, 1896, p. 77.
C. dorsalis Banks, Trans. Amer. Ent. Soc., XXIII, 1896, p. 77.
C. granulatus Banks, Journ. N. Y. Ent. Soc., 1895, p. 129.
C. nigra Banks, Trans. Amer. Ent. Soc., XXII, 1895, p. 12.
C. oblonga Banks, Trans. Amer. Ent. Soc., XXII, 1895, p. 13.

CYMBÆREMÆUS.

Cymbæremæus BERLESE, Acari, Myr. Scorp, Ital., 1896, fasc. 78.

C. marginalis BANKS, Trans. Amer. Ent. Soc., XXIII, 1896, p. 76 (*Eremæus*).

HERMANNIA.

Hermannia NICOLET, Arch. Mus. Paris, VII, 1855, p. 468.

H. quadriseriata BANKS, Insects, etc., Commander Isl., 1899, p. 349.
H. trinebulosa RILEY, Hubbard, Orange Insects, 1885, p. 216.

NEOLIODES.

Neoliodes BERLESE, Bull. Soc. Ent. Ital., XX, 1888, p. 47.

N. concentrica SAY, Journ. Phil. Acad., II, 1821, p. 73.—LE CONTE, Edit., II, 1859, p. 18.—BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 15 (*Liodes*).
N. floridensis BANKS, Proc. Acad. Nat. Sci. Philad., 1906, p. 499.

NOTHRUS.

Nothrus KOCH, Crust. Myr. Arach. Deutsch., fasc. 2, 1835.

N. banksi MICHAEL, Das Tierreich. Lief. 3, Oribat., 1898, p. 70.
furcatus BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 15 (not Koch).
N. bipilus BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 14.
N. excisus BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 15.
N. rugulosus BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 15.
N. simplex BANKS, Journ. New York Ent. Soc., 1895, p. 130.
N. taurinus BANKS, Proc. Acad. Nat. Sci. Philad., 1906, p. 499.
N. truncatus BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 14.

SCUTOVERTEX.

Scutovertex MICHAEL, Journ. Roy. Micr. Soc., II, 1879, p. 241.

S. marinus BANKS, Trans. Amer. Ent. Soc., XXIII, 1896, p. 77 (*Nothrus*).
S. petrophagus BANKS, Entom. News, 1906, p. 194.

HOPLODERMA.

Hoploderma MICHAEL, Das Tierreich, III, 1898, p. 77.

H. granulata BANKS, Canad. Entom., 1902, p. 175.
H. setosa BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 16 (*Hoplophora*).
H. sphærula BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 16 (*Hoplophora*).

PHTHIRACARUS.

Phthiracarus PERTY, Allg. Naturg., III, 1841, p. 874.

P. arctata RILEY, 6th Mo. Rept., 1874, p. 53 (*Hoplophora*).—BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 16 (*Tritia*).
P. cryptopus BANKS, Proc. California Acad. Science (3), III, 1904, p. 367.
P. glabrata SAY, Journ. Phil. Acad., II, 1821, p. 73.—LE CONTE, Edit., II, 1859, p. 18.—BANKS, Trans. Amer. Ent. Soc., XXII, 1895, p. 16 (*Tritia*).

ORIBATIDÆ.

(Unplaced.)

O. aspidioti ASHMEAD, Can. Entom., 1879, p. 93 (*Oribata*).
N. malleolus KARPELLES, Berl. Ent. Zeitschr., 1884, p. 34 (*Nothrus*).
N. ovivorus PACKARD, Guide Study Insects, 1869, p. 664 (*Nothrus*).
N. pileiformis KARPELLES, Berl. Ent. Zeitsch., 1884, p. 33 (*Nothrus*).
O. quadripilis FITCH, 3rd N. Y. Rept., 1856, p. 442 (*Oribata*).

Family TARSONEMIDÆ.

SITEROPTES.

Siteroptes AMERLING, Lotos, 1861, p. 24.

S. carnea BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 140.

TARSONEMUS.

Tarsonemus CANESTRINI and FANZAGO, Atti. Soc. Ven.-Trentino, V, 1876, p. 141.

T. pallidus BANKS, Proc. Ent. Soc. Wash., IV, 1899, p. 295.

PEDICULOIDES.

Pediculoides TARGIONI-TOZZETTI, Ann. d. Agricol., I, 1878, p. 271.

P. ventricosus NEWPORT, Trans. Linn. Soc., London, XXI, 1853, p. 95.—BRUCKER, Bull. Sci. France, Belgique, XXXV, 1900, pp. 355–442, 4 pls.

PIGMEOPHORUS.

Pigmeophorus KRAMER, Arch. f. Naturg., XLIII, 1877, p. 254.

P. americanus BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 139.

DISPARIPES.

Disparipes MICHAEL, Trans. Linn. Soc. XVII, 1885, p. 390.

D. americanus BANKS, Proc. Ent. Soc. Wash., VII, 1906, p. 139.

Family TYROGLYPHIDÆ.

HISTIOSTOMA.

Histiostoma KRAMER, Arch. f. Naturg., XLII, 1876, p. 105.

H. americanum BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 11.
H. brevipes BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 11.
H. gracilipes BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 10.

GLYCIPHAGUS.

Glyciphagus HERING, Nova Acta Acad. Leop. (2), XVIII, 1838, p. 619.

G. obesus BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 12.

G. robustus BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 13.

TYROGLYPHUS.

Tyroglyphus LATREILLE, Précis Caract. Ins., 1796, p. 185.

T. americanus BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 16.

T. armipes BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 18.

T. breviceps BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 17.

T. cocciphilus BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 16.

T. farinæ DE GEER, Mém. Hist. Ins., VII, 1778, p. 97; Das Tierreich, Lief. 7, 1899, p. 137.—BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 14.

T. lintneri OSBORN, Science, 1893, p. 360.—LINTNER, 10th N. Y. Rept., 1895, p. 452.—BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 15.

T. heteromorphus FELT, 11th New York Rept., 1896, p. 254.—BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 18.

T. longior GERVAIS, Insectes Aptères, III, 1844, p. 262.—BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 14.

T. ribis FITCH, 3rd New York Rept., 1856, p. 424. [Possibly a *Rhizoglyphus*.]

T. terminalis BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 17.

RHIZOGLYPHUS.

Rhizoglyphus CLAPARÈDE, Zeits. wiss. Zool., XVIII, 1869, p. 506.

R. elongatus BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 22.

R. hyacinthi BOISDUVAL, Entom. horticole, 1867, p. 86.—BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 21.

echinopus FUMOUZE and ROBIN, Journ. Anat. Physiol. V, 1868, p. 278.

R. longitarsis BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 22.

R. phylloxeræ RILEY, 6th Missouri Rept., 1874, p. 52.—BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 20.

R. rhizophagus BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 21.

R. tarsalis BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 20.

MONIEZIELLA.

Monieziella BERLESE, Acari, Myriop. Scorp. Ital., Cryptostigmata, Sarcoptidæ, 1897, p. 106.

M. angusta BANKS, Techn. Bull. no. 13, Bur. Entom. U. S. Dept. Agric., 1906, p. 23.
M. brevitarsis BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 24.
M. longipes BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 23.

CARPOGLYPHUS.

Carpoglyphus ROBIN, Bull. Soc. Imp. Nat. Moscou, XXXIII, 1860, p. 16.

C. passularum HERING, N. Acta. Acad. Leop., XVIII, 1838, p. 618.—MÉGNIN, Parasit., 1880, p. 141.—BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 25.
anonymus HALLER, Jahresb. Ver. Württemb., XXXVIII, 1882, p. 297.

TRICHOTARSUS.

Trichotarsus CANESTRINI, Prosp. Acarof. Ital., III, 1888, p. 356.

T. osmiæ DUFOUR, Ann. Sci. Nat. (2), XI, 1839, p. 276.—BANKS, Canad. Entom., 1902, p. 176; Techn. Bull. no. 13, Bur. Entom., U. S. Dept. Agric., 1906, p. 26.
T. xylocopæ DONNADIEU, Ann. Sci. Nat. (5), X, 1868, p. 70.—OSBORN, Amer. Nat., 1894, p. 1021.—BANKS, Techn. Bull. no. 13, Bur. Entom., U. S. Dept Agric., 1906, p. 25.

Family CANESTRINIIDÆ.

HEMISARCOPTES.

Hemisarcoptes LIGNIÈRES, Mém. Soc. Zool. France, 1893, p. 17.

H. malus SHIMER, Trans. Amer. Ent. Soc., I, 1868, p. 368 (*Acarus*).
coccisugus LIGNIÈRES, Mém. Soc. Zool. France, 1893, p. 17.

Family ANALGESIDÆ.

PTEROLICHUS.

Pterolichus ROBIN, C. R. Acad. Sci., Paris, LXVI, 1868, p. 786.

P. aquilinus TROUESSART, Journ. Microgr., VIII, 1884, p. 573.
P. buchholzi CANESTRINI, Atti. Inst. Veneto. (5), V, 1878, p. 64.
P. longiventer MÉGNIN and TROUESSART, Journ. Microgr., VIII, 1884, p. 261.

FREYANA.

Freyana HALLER, Zeits. wiss. Zool., XXX, 1877, p. 81.

F. anserina TROUESSART and MÉGNIN, Bull. Soc. Angers, XIV, 1884, p. 40.
F. caput-medusæ TROUESSART, Bull. Soc. Angers, XVI, 1886, p. 100 (*Michaelichus*).

ALLANALGES.

Allanalges TROUESSART, Bull. Soc. Angers, XVI, 1886, p. 137.

A. gracilepinnata HALLER, Arch. f. Naturg., 1882, p. 72.

PROCTOPHYLLODES.

Proctophyllodes ROBIN, C. R. Acad. Sci., Paris, LXVI, 1868, p. 786.

P. reticulifer TROUESSART and NEUMANN, Bull. sci. France Belgique, XIX, 1888, p. 371.—CANESTRINI, Das Tierreich, Lief. 7, 1899, p. 119.

MEGNINIA.

Megninia BERLESE, Acari, Myr. Scorp. Ital., fasc. 4, 1884.

M. albida TYRRELL, Trans. Ottawa Field Nat. Club, no. 3, 1882, p. 46.
M. aculeatus HALLER, Arch. f. Naturg., 1882, p. 55.
M. forcipatus HALLER, Arch. f. Naturg., 1882, p. 66.
M. gladiator HALLER, Arch. f. Naturg., 1882, p. 63.
M. pici-majoris BUCHHOLZ, Bemerk. Gatt., Dermaleichus, 1869, p. 43.
socialis ROBIN and MÉGNIN, Journ. Anat. Physiol., XIII, 1877, p. 511.
M. tyrrelli HALLER, Arch. f. Naturg., 1882, p. 55.

ANALGES.

Analges NITZSCH, Ersch. and Gruber, Ency. Wiss. u. Künste, I, 1818, p. 250.

A. cremidonotus TROUESSART, Bull. Soc. Angers, XXVIII, 1899, p. 29.
A. digitatus HALLER, Arch. f. Naturg., 1882, p. 52.
A. longispinosus TYRRELL, Trans. Ottawa Field Nat. Club, no. 3, 1882, p. 45.
A. passerinus LINNÆUS, Syst. Nat., X, 1758, p. 616.
fringillarum KOCH, Crust. Myr. Arach. Deutsch., fasc. 33, 1848, pl. XII.
A. pici-pubescentis PACKARD, Amer. Nat., III, 1869, p. 493.
A. tridentulatus HALLER, Arch. f. Naturg., 1882, p. 54.
A. tyranni TYRRELL, Trans. Ottawa Field Nat. Club, no. 3, 1882, p. 45.

PTERONYSSUS.

Pteronyssus ROBIN, C. R. Acad. Sci., Paris, LXVI, 1868, p. 786.

P. simplex HALLER, Arch. f. Naturg., 1882, p. 68.
P. speciosus TYRRELL, Trans. Ottawa Field Nat. Club, no. 3, 1882, p. 47.
P. tyrrelli CANESTRINI, Das Tierreich, Lief. 7, 1899, p. 79.
fuscus TYRRELL, Trans. Ottawa Field Nat. Club, no. 3, 1882, p. 48 (preoccupied).

FALCULIFER.

Falculifer RAILLIET, Recueil, Méd. Vétér., 1896, p. 6.

F. rostratus BUCHHOLZ, Bemerk., Gatt. Dermaleichus, 1869, p. 14.
falciger MÉGNIN, Journ. Anat. Physiol., XIII, 1877, p. 402 (*Pterolichus*).
Hypodectes and *Hypoderas* spp. GARMAN, Amer. Nat., 1884, p. 430.—KELLICOTT, Ins. Life, V, 1892, p. 77.—WARD, Psyche, VII, 1894, pp. 95–100; Science, 1902, p. 911, (No. 388).

Family LISTROPHORIDÆ.

SCHIZOCARPUS.

Schizocarpus TROUESSART, C. R. Soc. Biol., Paris, XLVIII, 1896, p. 109.

S. mingaudi TROUESSART, Bull. Soc. Ent. France, 1896, pp. 28, 93.
truncatum KRAMER, Zool. Anzeiger, 1896, p. 134 (*Haptosoma*).

Family SARCOPTIDÆ.

CHORIOPTES.

Chorioptes GERVAIS, Gerv. et Van Bened., Zool. Méd., I, 1859, p. 463.

C. equi GERLACH, Krätze, 1857, p. 103.
spathiferus MÉGNIN, Parasit., 1880, p. 200.
communis var. *equi* LUGGER, 2nd Ann. Rept. State Entom. Minnesota, 1896, p. 76.

OTODECTES.

Otodectes CANESTRINI, Prosp. Acarof. Ital., VI, 1894, p. 726.

O. cynotis HERING, N. Acta. Acad. Leop., XVIII, 1838, p. 600; Ann. Soc. Ent. France, 1849, p. XXXIV.
auricularum RAILLIET, Zool. Méd., (2), 1893, p. 676 (*Chorioptes*).
ecaudatus MÉGNIN, Parasit., 1880, p. 203 (*Chorioptes*).

NOTOEDRES.

Notoedres RAILLIET, Zool. Med. (2), 1893, p. 660.

N. cati HERING, N. Acta. Acad. Leop., XVIII, 1838, p. 605.—GERLACH, Krätze, 1857, p. 149.
notoedres var. *cati* MÉGNIN, Parasit., 1880, p. 174.
minor var. *cati* TYRRELL, Proc. Can. Inst., I, 1883, p. 332.
minor LUGGER, 2nd Ann. Rept. Entom. Minnesota Expt. Stat., 1896, p. 61.

CNEMIDOCOPTES.

Cnemidocoptes FÜRSTENBERG, Mt. Ver. Neu Vorpomm. u. Rügen, II, 1870, p. 56.

C. gallinæ RAILLIET, Bull. Soc. Zool. France, XII, 1887, p. 132 (variety of *C. lævis*).

C. mutans ROBIN, Bull. Soc. Moscou, XXXIII, 1860, p. 184.—MÉGNIN., Parasit., 1880, p. 175.
viviparus FÜRSTENBERG, Mt. Ver. Vorpomm., II, 1870, p. 56.—LUGGER, 2nd Ann. Rept. Entom. Minnesota Expt. Stat., 1896, p. 63

PSOROPTES.

Psoroptes GERVAIS, Ann. Sci. Nat. (2), XV, 1841, p. 9.

P. bovis GERLACH, Krätze und Raube, 1857, p. 114.—PETERS, Bull. No. 74, Nebraska Agric. Exp. Station, 1902, pp. 5–10.

P. ovis HERING, N. Acta Acad. Leop., XVIII, 1838, p. 594.
longirostris var. *ovis* MÉGNIN, Parasit., 1880, p. 192.

communis var. *ovis* CURTICE, Anim. Paras. Sheep, 1890, p. 56.—GILLETTE, Can. Entom., 1899, p. 9.—SPENCER, Bull. 124, Virginia Agric. Exp. Sta., May, 1901, pp. 41–46.—KNOWLES, Journ. Comp. Med. Vet. Archives, Philad., Oct., 1900.

SARCOPTES.

Sarcoptes LATREILLE, Gen. Crust. Ins., I, 1806, p. 151.

S. **canis** GERLACH, Krätze und Raube, 1857, p. 141.

S. **equi** GERLACH, Krätzm, 1857, p. 72.—MÉGNIN, Parasit., 1880, p. 164.—LUGGER, 2nd Ann. Rept. Entom. Minnesota Exp. Stat., 1896, p. 59.—SPENCER, Bull. 125, Virginia Agric. Exp. Sta., June, 1901, pp. 49–52, 2 figs.—KNOWLES, Journ. Comp. Med. Vet. Archives, Philad., Oct., 1900.—PETERS, Bull. no. 74, Nebraska Agric. Exp. Station, 1902, pp. 1–27, 7 figs.

S. **ovis** MÉGNIN, Parasit., 1880, p. 168.—CURTICE, Anim. Parasit. Sheep, 1890, p. 54.

S. **scabiei** DE GEER, Mém. Hist. Ins., VII, 1778, p. 94.—MÉGNIN, Parasit., 1880, p. 169.

hominis HERING, N. Acta Acad. Leop., XVIII, 1838, p. 584.

S. **scabieicrustosæ** FÜRSTENBERG, Krätzm. Menschen u. Thiere, 1861, p. 212; Insect Life, V, 1893, p. 283.

S. **suis** GERLACH, Krätze und Raube, 1857, p. 137.—MÉGNIN, Parasit., 1880, p. 163.—LUGGER, 2nd Ann. Rept. Entom. Minnesota Exp. Stat., 1896, p. 58.

Family CYTOLEICHIDÆ.

LAMINOSIOPTES.

Laminosioptes MÉGNIN, Paras. et Mal. par., 1880, p. 151.

L. **cysticola** VIZIOLI, Giorn. Anat. Fisiol., I, 1870, p. 257.

gallinarum MÉGNIN, Parasit., 1880, p. 152.

CYTOLEICHUS.

Cytoleichus MÉGNIN, Journ. Anat. et Physiol., XV, 1879, p. 150.

C. **nudus** VIZIOLI, Giorn. Anat. Fisiol., I, 1870, p. 257.

sarcoptoides MÉGNIN, Parasit., 1880, p. 153.

Family ERIOPHYIDÆ.

ERIOPHYES.

Eriophyes SIEBOLD, Jahresber. Schles. Ges. Kult., XXVIII, 1850, p. 89.

E. **abnormis** GARMAN, App. 12th Illinois Rept., 1883, p. 134.

E. **aceris-crumena** RILEY, Amer. Entom. and Bot., II, 1870, p. 339.

accricola GARMAN, App. 12th Illinois Rept., 1883, p. 135.

E. **ænigma** WALSH, Proc. Amer. Entom. Soc., III, 1864, p. 608 (as *Cecidomyia*); VI, 1868, p. 227.

E. **brevitarsus** FOCKEU, Rev. biol. Nord. France, III, 1890, p. 3.

E. **caulis** COOK, 29th Ann. Rept. Geol. Indiana, 1904, p. 859.

E. **fraxini** GARMAN, App. 12th Illinois Rept., 1883, p. 136.

E. **malifoliæ** PARROTT, Bull. 283, New York Exp. Station, 1907, p. 312.

E. nyssæ TROTTER, Marcellia, II, 1903, p. 67.

E. phlœocoptes NALEPA, SB. Akad. Wien, XCIX, Math.-natur. Cl., 1890, p. 54.—GARMAN, Ann. Rept. Kentucky Bur. Agric., 1894, p. 286.—SLINGERLAND, Can. Ent., Dec., 1895, pp. 329–331, 1 pl.

E. populi NALEPA, Sitzungsber. Akad. Wien, XCIX, Math. nat. Cl., 1890, p. 43.

E. pruni-crumena WALSH, 1st Ann. Rept. Nox. Insects Illinois, 1868, p. 55.

(?) *padi* NALEPA, Sitzber. Akad. Wiss. Wien, Math. natur. Cl., XCIX, 1890, p. 55.

E. pyri PAGENSTECHER, Verh. Ver. Heidelberg, I, 1857, p. 48.—GARMAN, App. 12th Illinois Rept., 1883, p. 140.—SLINGERLAND, Insect Life, V, 1892, p. 104; Bull. No. 61, Cornell Agric. Exp. Sta., 1893, pp. 317–328.—PARROTT, Bull. 283, New York Exp. Station, 1907, p. 291.

E. quadripes SHIMER, Trans. Amer. Entom. Soc., II, 1869, p. 319.—GARMAN, App. 12th Illinois Rept., 1883, p. 135.

E. querci GARMAN, App. 12th Illinois Rept., 1883, p. 138.

E. ryderi BANKS, new species.—RYDER, Amer. Nat., XIII, 1879, p. 704, fig.

E. salicicola GARMAN, App. 12th Illinois Rept., 1883, p. 138.

E. semen WALSH, Proc. Amer. Entom. Soc., III, 1864, p. 606 (as *Cecidomyia*); VI, 1868, p. 227.

E. serotinæ BEUTENMÜLLER, Bull. Amer. Mus. Nat. Hist., IV, 1892, p. 278.

cerasi-crumena WALSH, MSS., 1st Ann. Rept. Nox. Insects Illinois, 1868, p. 55.

E. thujæ GARMAN, App. 12th Illinois Rept., 1883, p. 138.

E. tristriatus NALEPA, Anz. Akad. Wien, XXVI, 1889, p. 162.

E. ulmi GARMAN, App. 12th Illinois Rept., 1883, p. 136.

E. vitis LANDOIS, Zeitsch. wiss. Zool., XIV, 1864, p. 353.—FORBES, 14th Rept. State Entom. Illinois, 1885, p. 84; Ann. Rept. Dept. Agric. (Washington), 1887, p. 391.—BIOLETTI, Bull. no. 136, California Agric. Exp. Station, 1901, 7 pp., 4 figs.

PHYLLOCOPTES.

Phyllocoptes NALEPA, Sitzungsber. Akad. Wiss. Wien, Math.-natur. Cl., XCVIII, Pt. 1, 1889, p. 116.

P. cornutus BANKS, Proc. Ent. Soc. Washington, VII, 1906, p. 141.

P. oleivorus ASHMEAD, Can. Entom., 1879, p. 160.—HUBBARD, Orange Insects, 1885, p. 107.—MARLATT, Yearbook U. S. Dept. Agric., 1900, p. 285.

P. schlechtendali NALEPA, Sitzungsber. Akad. Wissensch. Wien, Math.-natur. Cl., XCIX, 1890, p. 62.—PARROTT, Science, XXIII, 12 Jan., 1906, p. 73; Bull. 283, New York Exp. Station, 1907, p. 314.

EPITRIMERUS.

Epitrimerus NALEPA, Das Tierreich, Lief. 4, Erioph., 1898, p. 61.

E. piri NALEPA, Nova Acta Acad. Leop., LXI, 1894, p. 321.—PARROTT, Science, XXIII, 12 Jan., 1906, p. 73; Bull. 283, New York Exp. Station, 1907, p. 313.

CECIDOBIA.

Cecidobia BANKS, Proc. Ent. Soc. Washington, VII, 1906, p. 141.

C. salicicola BANKS, Proc. Ent. Soc. Washington, VII, 1906, p. 142.—NALEPA, Marcellia, V, 1906, p. 124.

Family DEMODECIDÆ.

DEMODEX.

Demodex OWEN, Lect. Invert. Anat., 1843, p. 252.

D. bovis STILES, Canad. Entom., 1892, p. 286.

D. folliculorum SIMON, Arch. Anat. Physiol. Med., 1842, p. 218 (*Acarus*).—MÉGNIN, Parasit, 1880, p. 266.

hominis LEYDIG, Arch. Naturg., XXV, 1859, p. 345.

D. phylloides CSOKOR, Oesterr. Vierteljahrschrift. f. Veterinärkunde, LI, 1879, p. 133—WRIGHT, Proc. Can. Inst. (3), I, 1883, p. 275.

Family UNKNOWN.

concolor HALDEMANN, Binney, Terr. Air-Breathing Mollusks U. S., II, 1851, p. 107 (*Hypopus*).

gryllaria LE BARON, 2nd Illinois Rept., 1871, p. 61 (*Atomus*).

odontalgiæ FITCH, 14th New York Rept., 1871, p. 371 (*Ixodes*). [Not an Ixodes. Perhaps an Oribated nymph, or possibly something like *Dermacarus* in Tyroglyphidæ; no *Gamasid* will fit.]

americanus RILEY, 6th Missouri Rept., 1874, p. 122 (*Leptus*).

irritans RILEY, 6th Missouri Rept., 1874, p. 122 (*Leptus*).

aranæ SAY, Journ. Phil. Acad., II, 1821, p. 80.—LE CONTE, Edit., II, 1859, p. 23 (*Leptus*).

comata SAY, Journ. Phil. Acad., II, 1821, p. 82.—LE CONTE, Edit., II, 1859, p. 23 (*Ocypete*).

hispus SAY, Journ. Phil. Acad., II, 1821, p. 81.—LE CONTE, Edit., II, 1859, p. 23 (*Leptus*).

INDEX.

A NEW HORNED RODENT FROM THE MIOCENE OF KANSAS.

By James Williams Gidley,

Of the Department of Geology, United States National Museum.

In 1902[a] Dr. W. D. Matthew described a new and most interesting Mylagaulid rodent, *Ceratogaulus rhinocerus*, from the middle Miocene beds at Pawnee Buttes, Colorado. The genus is especially distinguished by a pair of well developed horncore-like processes situated on the nasal bones, a most unexpected and unique character for a rodent and entirely unknown prior to Matthew's discovery.

While recently unpacking some boxes of Miocene fossils, which for a number of years have been stored away in the United States National Museum, a second specimen was found, representing a new but closely related genus in which nasal horns are even more prominently developed than in *Ceratogaulus*. This specimen, a nearly complete skeleton, was originally obtained by the late Mr. John Bell Hatcher, while collecting fossils for Prof. O. C. Marsh under the auspices of the United States Geological Survey, in 1885. It comes from the upper Miocene beds near Long Island, Kansas. Although obtained so long ago, the specimen when found had apparently not been unpacked since arriving from the field and was probably never examined by Marsh.

With this more complete material it is now possible to confirm some of Matthew's conclusions regarding the association of the material described by him, to determine more definitely the affinities of the family Mylagaulidæ, and to give a more complete knowledge of the osteological characters of this little known but interesting group of rodents.

I have been greatly aided in the preparation of this paper by having for comparison all the Mylagaulid material in the American Museum of Natural History collection, which was generously placed at my disposal through the kindness of Prof. Henry F. Osborn and Dr. W. D. Matthew.

[a] Bull. Amer. Mus. Nat. Hist., XVI, 1902, p. 291.

Family MYLAGAULIDÆ Cope.

This family was not well characterized by Cope, owing to the insufficient material known to him, but with the discovery of better specimens it has since been more adequately defined by Doctor Matthew as follows, in part:[a]

> The characters amply confirm Prof. Cope's separation of it as the type of a distinct family. Its place is among the Sciuromorpha, but without close relationship to the other Sciuromorph families, the nearest being the Sciuridæ. * * * The antorbital foramen is close to the zygomata, as in *Meniscomys*, instead of considerably anterior to it as in most modern rodents. * * * The family distinctions from the Sciuridæ are the great enlargement of the fourth premolar in the lower jaw and of a corresponding tooth in the upper one, with reduction and final disappearance of the teeth posterior to it, and the tendency to hypsodont teeth with closed enamel lakes.

To these characters may be added another, distinctive of the family, namely, the location of the origin of the long curved incisor of the lower jaw, which is situated within the coronoid process.

EPIGAULUS, new genus.

Generic characters.—More specialized throughout than any other Mylagaulid hitherto described. True molars much more reduced than in *Ceratogaulus*, with a corresponding increase in size of the large grinding premolars. Premolars and probably molars completely surrounded by a band of cement which is a functional part of the tooth. Nasal horn cores placed much farther back than in *Ceratogaulus*, their posterior borders being on a line with the anterior borders of the orbits. Nasals extend correspondingly farther back to a point nearly opposite the posterior border of the orbits.

Type of genus.—Epigaulus hatcheri.

EPIGAULUS HATCHERI, new species.

Type.—A nearly complete skeleton (Cat. No. 5485, U.S.N.M.). From the upper Miocene beds[b], near Long Island, Phillips County, Kansas.

Specific characters.—Size somewhat larger than any species of the Mylagaulidæ described. Horn cores high and pointed, their height equaling one-third the entire length of the skull. Width of occiput greater than that of the zygomatic arches. Enamel lakes in the premolars numerous, seven in number in the upper and nine in the lower in the type. Fore limb and foot highly modified for digging, the foot being armed with heavy, compressed claws of great length. Hind foot long and slender, with the outer two digits, IV and V, the heav-

[a] Memoirs Amer. Mus. Nat. Hist., I, Pt. 7, 1901, p. 377.

[b] According to Hatcher's field label: "From a calcareous sand layer 10 feet above the bone layer." The bone layer referred to is the famous quarry near Long Island, Kansas, which has yielded such quantities of Teleoceras remains.

iest. Tibia greatly modified and twisted laterally, throwing the long axis of the foot inward at nearly a right angle to the fore-and-aft plane of the leg.

Measurements for comparison with those given by Matthew for Ceratogaulus.

	Mm.
Length of skull	80
Width across arches	64
Width of occiput	75
Height of horn core	32
Length of horn core at base	17
Conjoined width of horn cores	28
Width across postorbital processes of frontals	27
Width across postorbital ridges (at narrowest point)	20
Depth of zygomatic arch beneath orbit	10
Length of diastema	23
Length of three upper cheek teeth	20
Length of upper p^4	13
Width of upper p^4	8
Length of lower jaw	62
Depth of lower jaw beneath molars	19
Height of lower jaw, angle to tip of coronoid process	44
Length of three lower cheek teeth	20
Length of lower p_4	15
Width of lower p_4	7

Detailed description and comparisons.—The skull viewed from below has about the proportions of that of *Ceratogaulus*, but the broader and more extended nasals, the more backwardly placed horn cores, and more broadly expanded occiput give to the upper part of the skull a markedly different appearance. The top of the cranium (Plate LIX, fig. *b*) is broad and saddle-shaped, the postorbital crests converging but slightly as they run backward to the occiput. The zygomatic arches are heavy and deep, with prominent postorbital processes. The postorbital processes of the frontals are less prominent than in *Ceratogaulus* or *Mylagaulus*. The infraorbital foramen is moderately large, piercing the broad anterior border of the zygomatic arch in much the same manner as in the existing genus *Aplodontia*. The squamosal expands postero-externally, sending a process outward and downward, which becomes visible on the occiput partially inclosing the posterior portion of the mastoid, as in *Aplodontia*. This character is also observable in the Spalacidæ and some members of the Sciuridæ. The base of the skull (Plate LX, fig. 1) shows some striking resemblances to that of *Aplodontia* (Plate LX, fig. 2) especially in general form and proportions and the arrangement of the foramina. The wings of the pterygoid and alisphenoid are subequal in size, with a shallow intervening fossa. The posterior opening of the alisphenoid canal is a well-rounded foramen, opening downward. The foramen rotundum and foramen ovale pierce the alisphenoid bone in *Epigaulus* and *Aplodontia*, and

the infraorbital foramen is similarly placed in both genera. In the characters as enumerated both the Aplodontidæ and Mylagaulidæ differ from the beavers and squirrels.

The palate is very narrow between the large premolars, widening more rapidly forward than backward. The space between the premolars and incisors is comparatively short, with the premaxillaries broadly rounded. The incisive foramen is placed well forward, as in *Aplodontia*.

The symphysis of the lower jaw (Plate LVIII, fig. *b*) is small and short. The jaw is heavy and deep in the region of the grinding teeth. The angle, as shown in Plate LXIII, fig. *g*, is broadly expanded and inflected, but to a less degree than in *Aplodontia*. The coronoid is comparatively high and straight, and is placed well back, capping the base of the long, curved incisor. The condyle is small with a long neck and irregularly rounded head.

The vertebræ.—The vertebral formula is, cervicals 7, dorsals 13, lumbars 6, sacrals 5, caudals ?. The vertebræ (Plate LXV) are comparatively short and heavy throughout, and the spinal column is greatly curved, as in the beaver. The atlas (Plate LXIII, fig. *c*) is unusually high and bears a short but well-defined spine. The posteriorly placed tranverse processes are blunt nodules of bone. The axis (Plate LXIII, fig. *d*), is short and carries a high, robust spine, which is widest antero-posteriorly at the base, but narrows rapidly and becomes widest transversely at the summit. The other cervicals in the type are only represented by fragments, but enough remains to show that the zygopophyses are broad and flat and considerably overlap each other in the same vertebra, indicating a considerable degree of flexibility of the neck. The first nine dorsal vertebræ have long, slender spines, but from this point they pass abruptly to the shorter, erect, heavy spines of the lumbar region.

The sacrum (Plate LXI, fig. *a*) does not differ materially from that of *Mylagaulus*, but is somewhat shorter, its attachments with the ilia are not extended so far forward and the vertebræ are even more completely fused. In both genera the first sacral is much the largest. The manner of fusion of the sacrum with the pelvis is suggestive of some of the modern Edentates, although it is nearly paralleled in *Spalax* and some species of the Geomyidæ (*Geomys floridanus*). The first two sacrals are anchylosed solidly with the ilia, the third is free, while the transverse processes of the posterior two vertebræ are completely fused with the anterior portion of the ischium, thus forming a large supra-acetabular foramen on either side.

The ribs, probably thirteen in number, are comparatively heavy throughout, their length and curvature indicating a large and well-rounded thorax. The first and ninth, or tenth, ribs are shown in Plate LXIV, figs. *b* and *c*.

The clavicles (Plate LXIV, fig. *g*) are very large, with heavy expanded ends for the cartilaginous attachments of the scapula and sternum.

There are three elements of the sternum preserved in the type (Plate LXIV, fig. *f*), including the presternum. This element is a comparatively large, irregularly shaped bone, with the transverse diameter somewhat exceeding the antero-posterior. Its ventral face is not keeled, and its thick anterior border presents a wide, shallow notch between the clavicles. In form and general proportions the presternum is curiously like the presternum or manubrium in the human skeleton. The remaining two elements, sections of the mesosternum, are very much smaller than the presternum, and are short and thick.

The bones of the fore limbs and feet are short and massive throughout, and are greatly modified. The scapula (Plate LXIII, fig. *a*, and Plate LXIV, fig. *a*) is large and Aplodontia-like in form. The spine is high, thin-edged, and bears a moderately well-developed mata-cromion. In *Castor* the spine is thick-edged and slopes rapidly from the acromion in a nearly straight line to the upper scapular border. The acromion is broken away in the type specimen. The glenoid cavity is shallow and continuous, with the anterior face of the heavy downwardly curved coracoid process.

The humerus, Plate LXI, fig. *c*, is short and massive, with its processes and ridges well developed for strong musculature. The great tuberosity extends well above the head of the humerus. The deltoid ridge is low but extends far down the humerus, ending in a strong spur-like process well below the middle point of the shaft. In *Ceratogaulus* this process is situated just below the middle of the shaft. In *Aplodontia* it is a little above that point. The supinator ridge is thin and very broadly expanded. This, together with the unusually well-developed condyles, gives a great breadth to the distal end of the humerus, which equals nearly one-half its entire length. There is present a large entepicondylar foramen, as in the Aplodontidæ and Sciuridæ.

The forearm, as compared with most other rodents, is unusually short, the shafts of the radius and ulna being only two-thirds the length of the humerus. The total length of the ulna, however, somewhat exceeds that of the humerus, owing to the great development of the olecranon. The shaft of the radius is small and round proximally, but is much expanded laterally at the distal end. The distal end of the ulna extends considerably below the end of the radius, as shown in Plate LXII, fig. *a*.

The only elements of the carpus preserved in the present specimen are the scapho-lunar and unciform. These are broad and thin, indicating a broad, short carpus. The metacarpus and proximal digits indicate also a very short and broad fore foot. The stout, heavy

phalanges are armed with remarkably long well-developed digging claws. The first digit is much reduced, but is still functional and bears a long, slender claw. The metacarpals are strongly keeled distally on their inferior faces, but the articular facet is very limited superiorly and locks solidly with the proximal phalanx when fully extended. This, together with a similar construction of the other phalanges, constitutes an arrangement of the foot, as a whole, unparalleled in any other group of rodents. The toes were capable of extreme flexing, but this perfect locking prevented them from reflexing except to a limited degree, as shown in Plate LXIV, fig. *e*. The claws thus permanently held in a curved position, together with the slight rotary motion possible to the radius and ulna, indicate that the animal walked on the outer side of the foot, with the claws turned inward in a manner somewhat similar to the Great Anteater. This position of the foot probably explains also the unusually great extension of the distal end of the ulna below that of the radius.

In the Spalacidæ the general proportions of the bones of the fore limb, except the scapula, are very similar to those of *Epigaulus*. The humerus has much the same modifications as the latter, but there is no entepicondylar foramen present in the forms examined. The radius and ulna also are of similar proportions, and the olecranon is long and stout. But the scapula is very unlike in its proportions, being much more slender than in *Epigaulus*.

The fore foot of *Epigaulus*, with its short digits and long heavy claws, suggests especially the highly modified foot of the Asiatic genus *Siphneus*, now called *Myotalpa*, but judging from the figures published by M. Alphonse Milne-Edwards[a] the distal articular facets of the metacarpals are not limited superiorly as in *Epigaulus;* hence the toes have more flexibility, and the foot also appears to come naturally into the usual plantigrade position assumed by most rodents in walking.

Compared with the *Mylagaulus* pelvis described by Matthew[b] the ilia diverge more anteriorly, and the attachment of the sacrum does not extend so far forward. (See Plate LXI, fig. *a*). The ischium is short, with a heavy tuberosity; the light pubes are connected by a slender rod-like symphysis, and the obturator foramen is large and broadly oval in outline. The pelvis, as a whole, resembles the pelvis of *Aplodontia* more than that of any of the other living forms examined, but it is comparatively shorter and of generally more robust proportions. A striking peculiarity of the pelvis is that it is placed at a much greater angle to the line of the vertebral column than is usual in rodents.

[a] Recherches pour servir à l'histoire naturelle des Mammifères. Paris, 1868 to 1874 pl. IX*b*.

[b] Mem. Am. Mus. Nat. Hist., I, Pt. 7, 1901, p. 379, fig. 6.

The hind limbs are lighter and more delicately proportioned than the fore limbs. The femur is nearly straight, with a rather slender shaft, but with well-developed trochanters and broadly expanded condyles. The greater trochanter extends somewhat above the head of the femur and is confluent with the greatly expanded third trochanter. The condyles are presented well backward. The surface for the patella is also unusually broad.

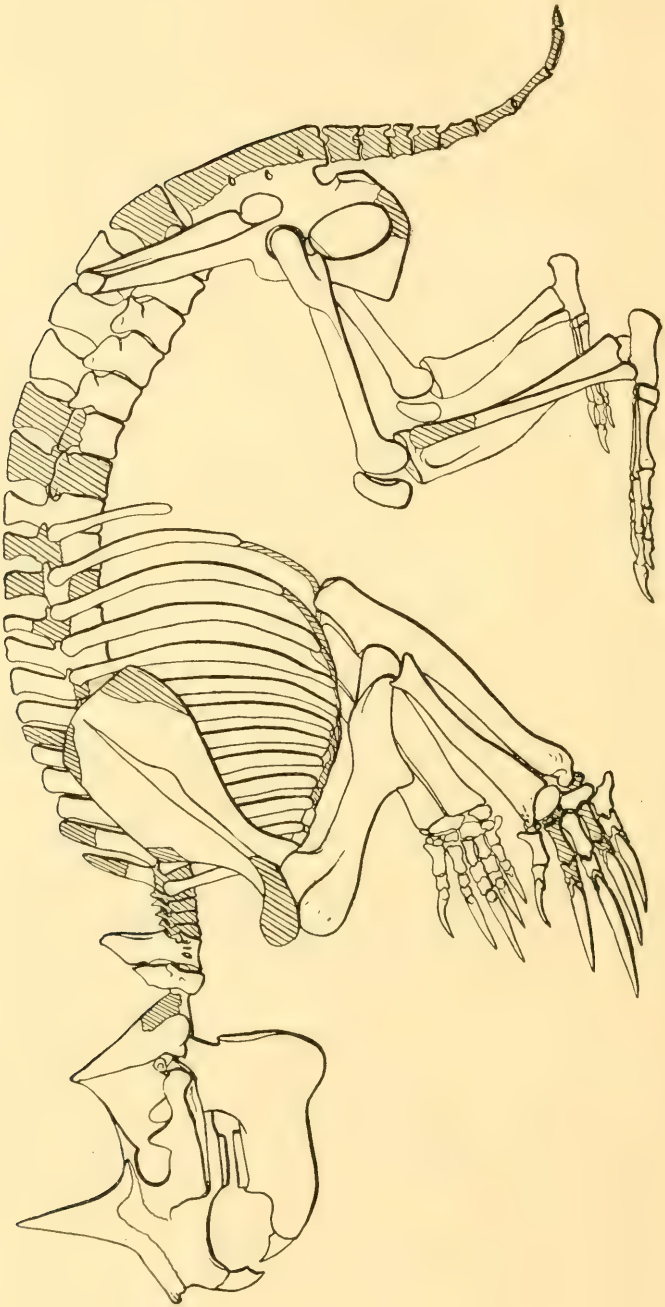
The tibia is comparatively short, not equaling the femur in length, and is remarkably modified. The cnemial crest is greatly expanded and extends well down the shaft, converting the proximal two-thirds into a thin expanded sheet of bone, deeply concave on the outer or fibular side and convex on the inner face. The entire shaft is greatly twisted laterally, as shown in Plate LXII, fig. *c*, the distal end being turned to such a degree as to carry the fibular facet to a position nearly in front, with the median ridge of the tibio-tarsal facet placed nearly at a right angle to the fore and aft plane of the tibia. This arrangement throws the foot inward at a great angle, with its outer side presented nearly forward when the tibia and femur are placed in the usual normal position. In *Mylagaulus* the tibia is apparently less modified.

The fibula is entirely free but much reduced. A considerable extent of the distal end of the shaft comes in contact with the tibia, as in *Aplodontia*.

The hind foot is wholly plantigrade and comparatively primitive. The toes, five in number, are long and slender, bearing small, delicately formed claws. The principal modification of the foot consists in the greater development of the two outer digits, IV and V, which are nearly equal in functional importance (see Plate LXIII, fig. *c*), and are much stouter than the others, suggesting the modification in the hind foot of some of the marsupials, especially the wombat. The cuboid is also unusually large and broad.

This most extraordinary twist of the tibia and consequent peculiar position of the hind foot is so radically different from that of mammals in general as almost to appear abnormal, but a possible explanation seems to suggest itself in the manner in which the foot may have been used. The fore feet and limbs so highly specialized and modified for digging, indicate that the habits of the animal were fossorial to a high degree. The principal function, therefore, of the hind limbs and feet may well have been for the purpose of removing the earth loosened and thrown backward under the body by the enormous claws of the fore feet. For this purpose the feet could be most effectively used in the position above indicated, and the outer toes thus being employed for the greater amount of work would naturally be the more strongly developed.

The outline restoration, figure (p. 634), was made from careful measurements of the bones, and indicates fairly well the general char-



RESTORATION OF EPIGAULUS HATCHERI. (ABOUT ONE-HALF NATURAL SIZE.)

acteristics and proportions of the skeleton of *Epigaulus hatcheri*. The animal, as a whole, seems to have been especially adapted to digging, for which occupation it was far better equipped than any of the gophers. The highly modified feet and unusually small orbits suggest that the animal may have lived almost exclusively under ground.

Questions of interest naturally arise in regard to the true meaning and possible utility of the great nasal horns. What is their real significance, and of what use could they have been to a burrowing rodent? Since such a development has no parallel in any of the living forms, any attempted solution of these questions must necessarily be based on conjecture. They may have been possessed by the males only, and in that event were probably used principally as fighting weapons. The discovery of more material will probably settle this point, and the question as well of whether the horns are peculiar to certain genera only, or are characteristic of the entire family. In any case they seem intended for use rather than for ornament, for they are strongly built and the whole skull is strengthened to resist severe strains placed upon them. The occiput, too, is broadly expanded for the attachment of heavy muscles, which would have enabled the animal to use the horns with great power. It seems not at all improbable, therefore, that they were utilized for burrowing. They may well have served as auxilliaries to the great claws to assist in rapid digging. This suggestion is borne out by the fact that the horns are closely twinned, making them especially effective as digging implements, and the tips of the nasals show signs of being protected by callosities, at least, if not by a second incipient pair of horns, suggesting that the nose often came in contact with the walls of the burrow.

Conclusions.—It seems evident from the above study that while this extinct group of highly specialized rodents apparently has some remote affinities to the Castoridæ and a somewhat nearer relationship to the Sciuridæ, as pointed out by Matthew, the family has a far greater number of characters in common with the Aplodontidæ, and shows besides some striking resemblances of general proportions to some of the Asiatic forms of the Spalacidæ. The resemblance to the latter family, however, seems to be due more to modifications of the skeleton for a similar special adaptation to burrowing habits than to any real relationship. In tooth development, the Mylagaulidæ have surpassed in specialization all other families of the Sciuromorpha, and could not have been ancestral to any of the living forms.

The affinities of the Mylagaulidæ to any of the known fossil forms is somewhat doubtful. Matthew and Peterson have suggested a possible relationship to *Euhapsis*, but the genus *Euhapsis* shows many more characters of the Castoridæ, and is more properly referable to that family.

EXPLANATION OF PLATES.

PLATE LVIII.

Epigaulus hatcheri (natural size).

a. Skull, anterior view.
b. Skull and lower jaw, side view.

PLATE LIX.

Epigaulus hatcheri (natural size).

a. Lower jaw, crown view.
b. Skull, superior view.

PLATE LX.

Fig. 1. *Epigaulus hatcheri*. Skull, palate view (natural size).
2. *Aplodontia rufus*. Skull, palate view (natural size).

PLATE LXI.

Epigaulus hatcheri (natural size).

a. Pelvis, superior view.
b. Right femur, anterior view.
c. Right humerus, anterior view.

PLATE LXII.

Epigaulus hatcheri (natural size).

a. Right radius and ulna, outside view.
b. Right fore foot, superior view (with median digit supplied from the left fore foot).
c. Right tibia and fibula, inside view.
d. Right hind foot, superior view.

PLATE LXIII.

Epigaulus hatcheri (natural size).

a. Left scapula, inferior view.
b. Left femur, posterior view.
c. Atlas, anterior view.
d. Axis, anterior view.
e. Cuboid, and metatarsals IV and V, superior view.
f. Left lower jaw, outer view.
g. Posterior portion of right lower jaw, outer view.

PLATE LXIV.

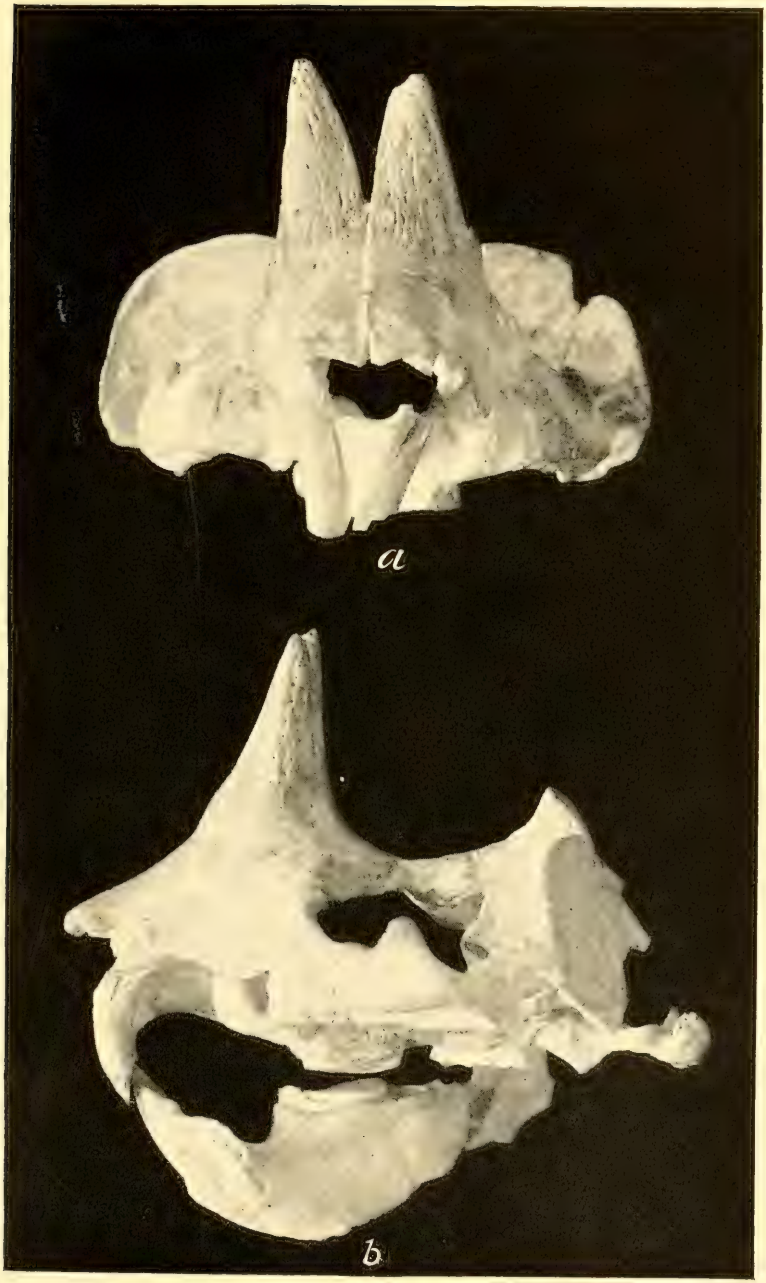
Epigaulus hatcheri (natural size).

a. Left scapula, outer view.
b. First rib of left side.
c. Ninth or tenth rib of left side.
d. Calcaneum of left hind foot.
e. Median digit of left fore foot, side view.
f. Presternum and two elements of mesosternum, inferior view.
g. Clavicle of left side.

PLATE LXV.

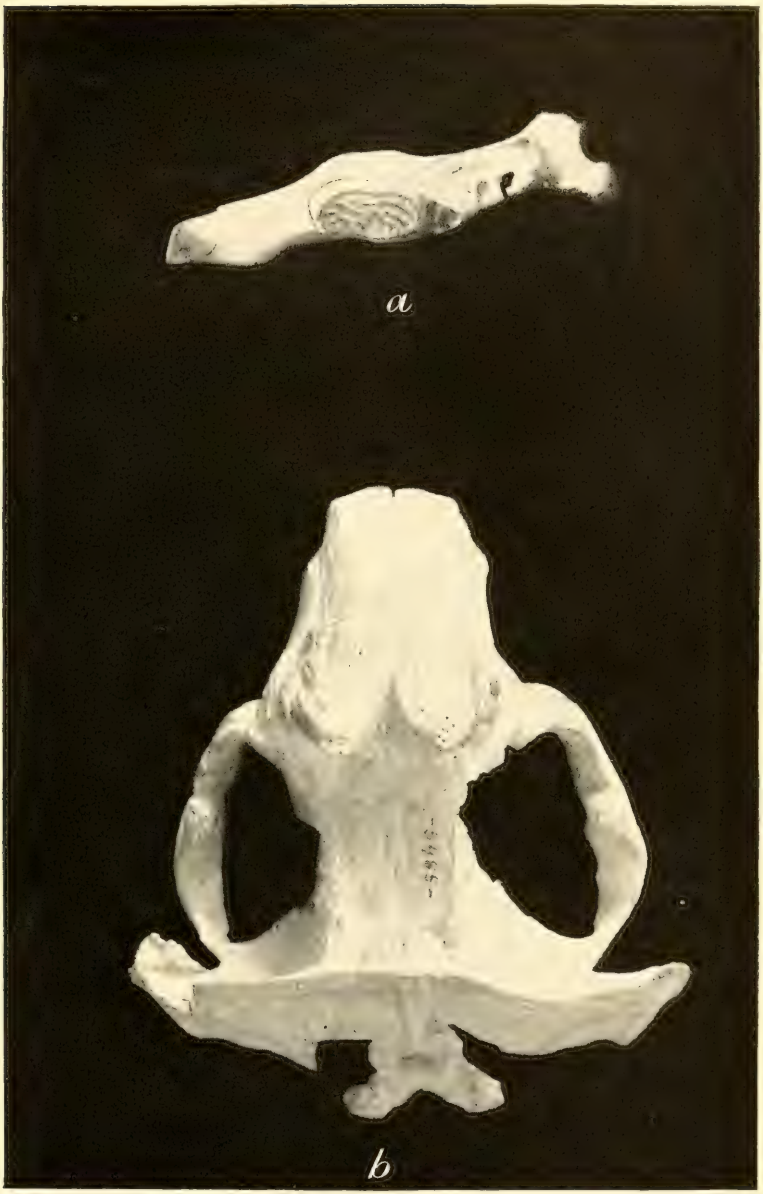
Epigaulus hatcheri (two-thirds natural size).

Vertebral column and pelvis, side view.



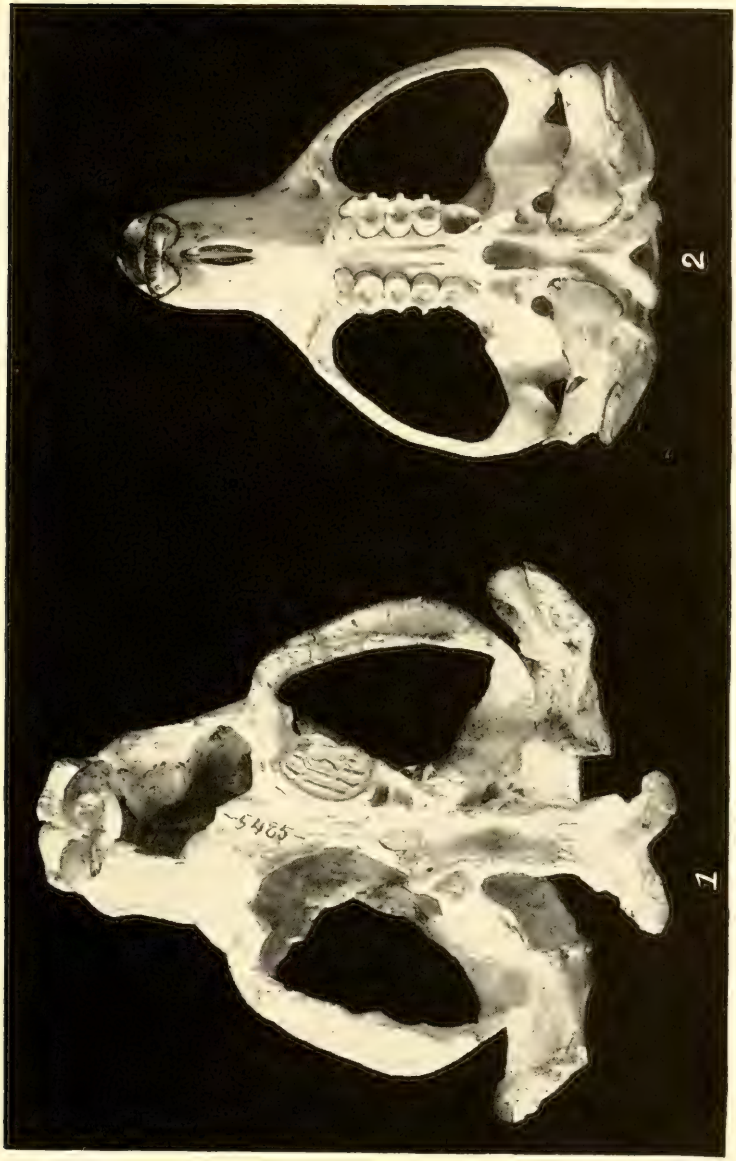
SKULL OF EPIGAULUS HATCHERI.

FOR EXPLANATION OF PLATE SEE PAGE 636.



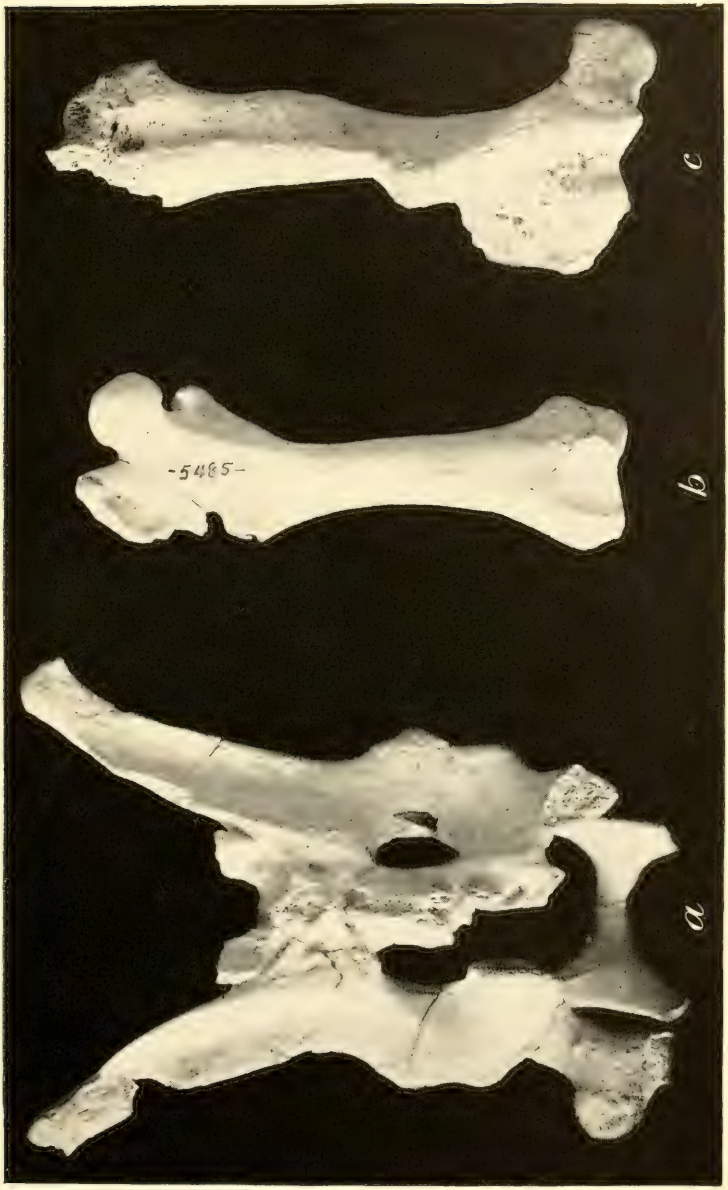
SKULL AND LOWER JAW OF EPIGAULUS HATCHERI.

FOR EXPLANATION OF PLATE SEE PAGE 636.



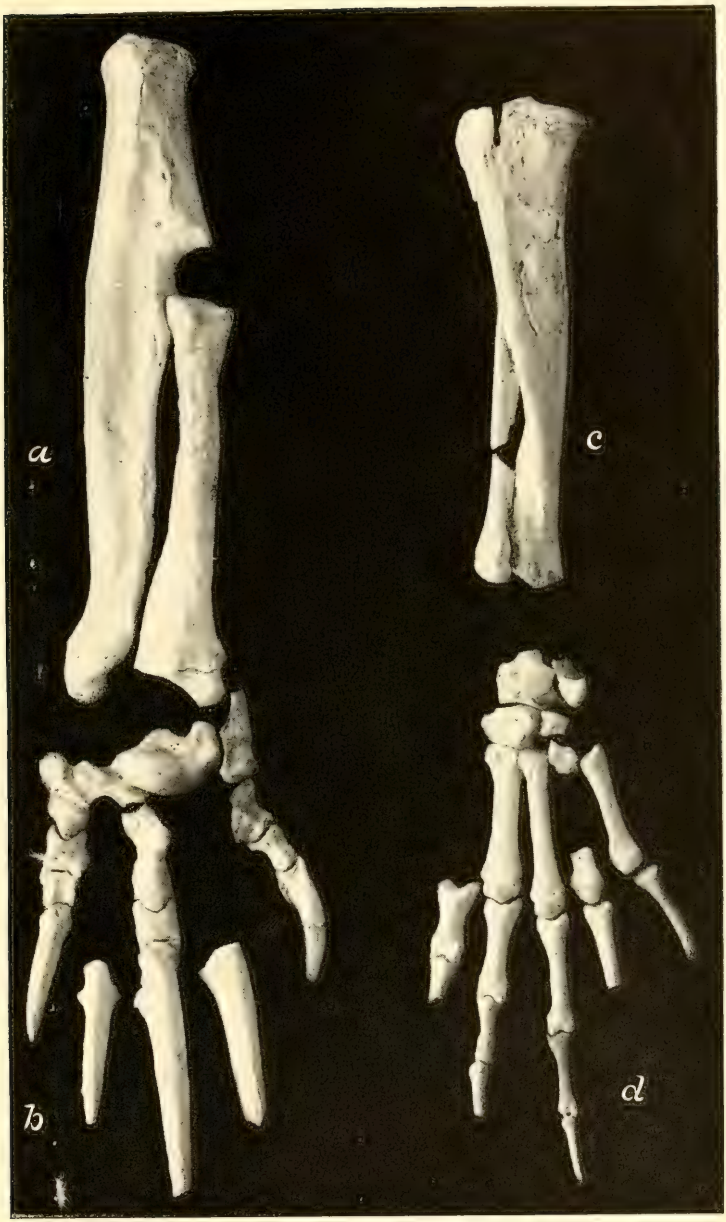
SKULLS OF (1) EPIGAULUS HATCHERI AND (2) APLODONTIA RUFUS.

FOR EXPLANATION OF PLATE SEE PAGE 636.



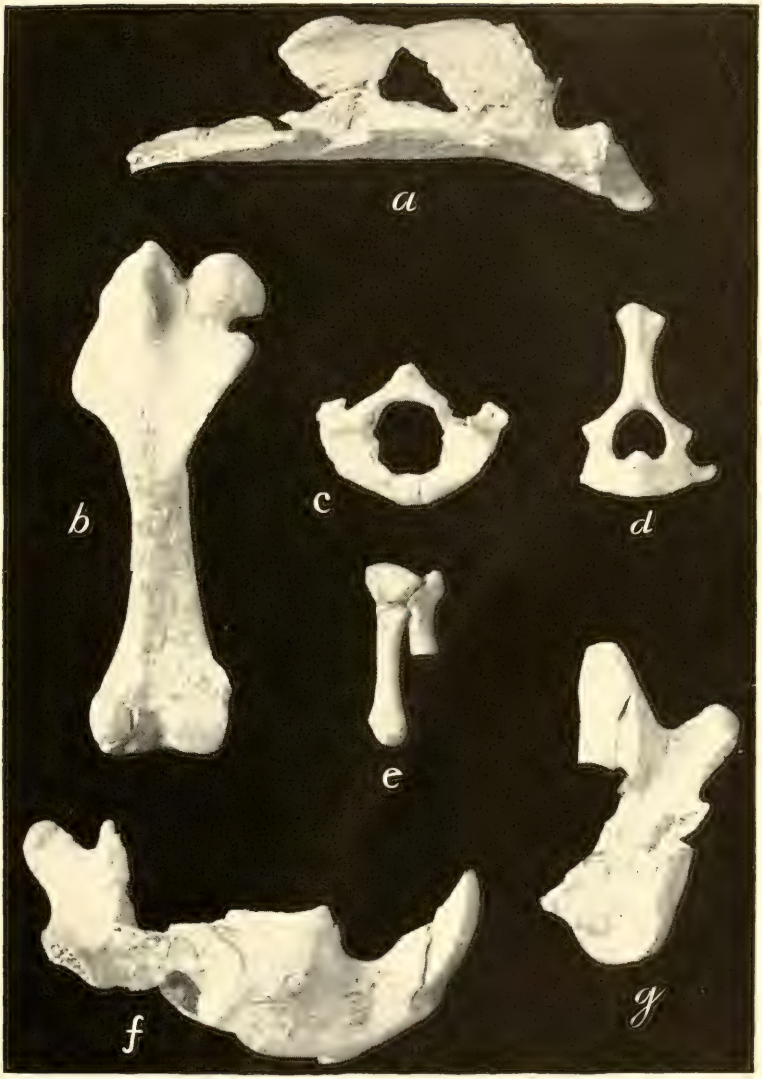
PELVIS, FEMUR, AND HUMERUS OF EPIGAULUS HATCHERI.

FOR EXPLANATION OF PLATE SEE PAGE 636.



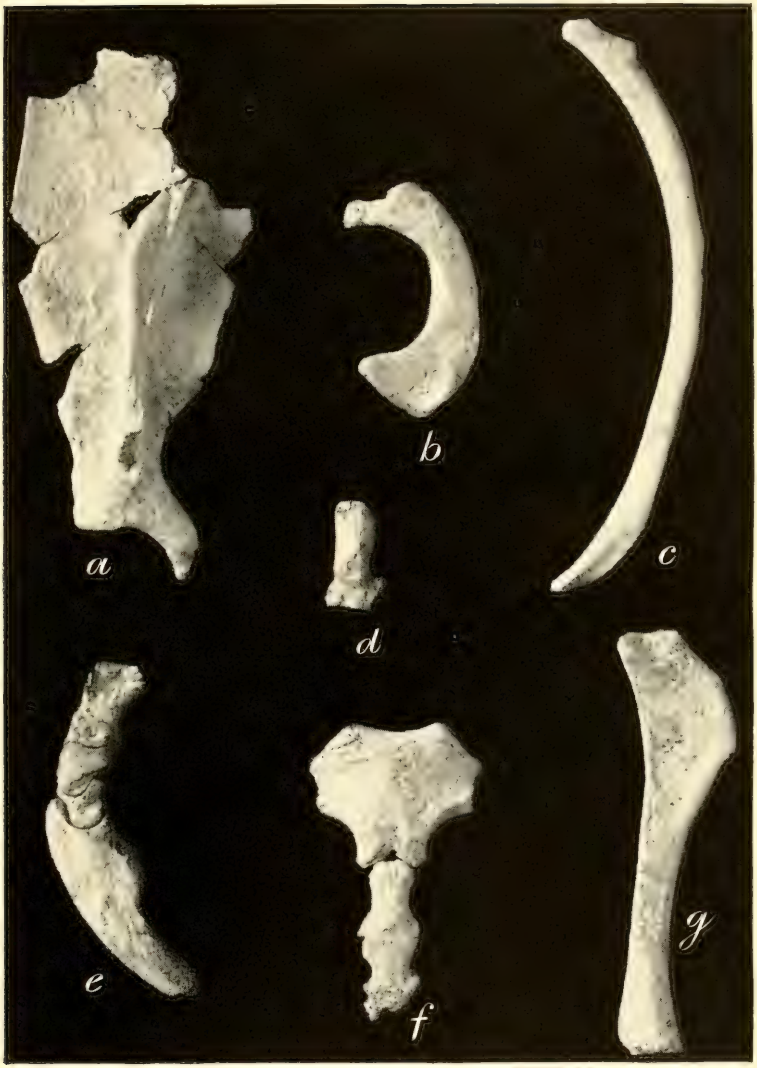
FORE AND HIND FOOT OF EPIGAULUS HATCHERI.

FOR EXPLANATION OF PLATE SEE PAGE 636.



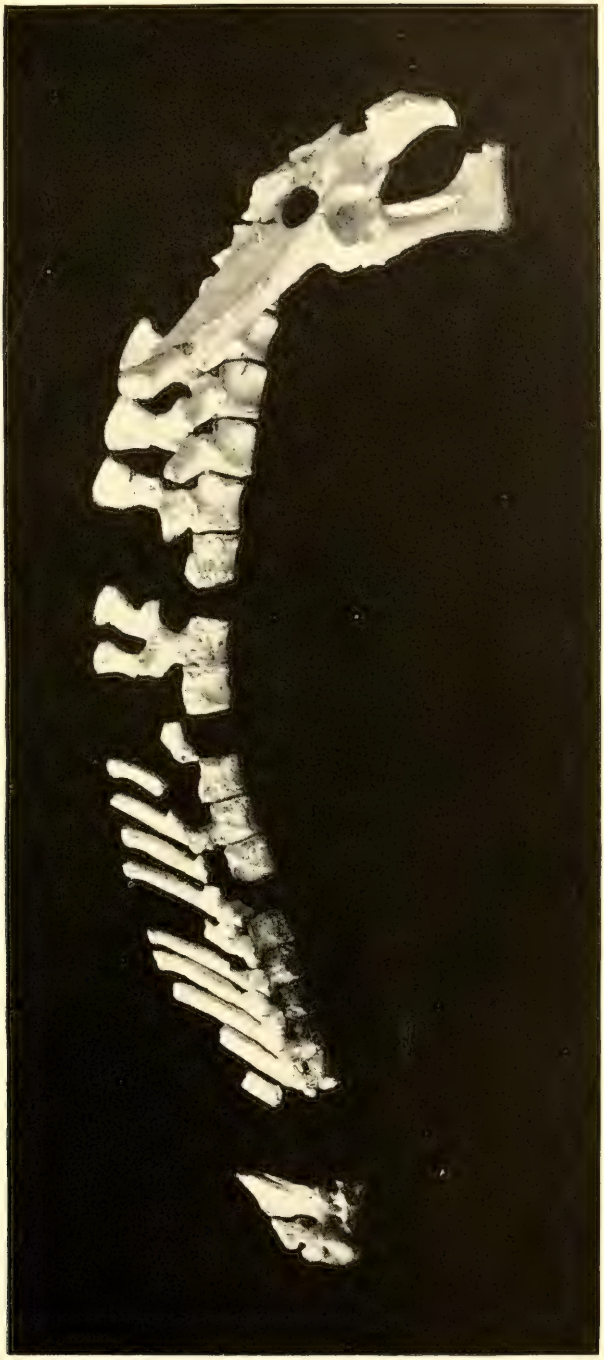
LOWER JAW AND SKELETON BONES OF EPIGAULUS HATCHERI.

FOR EXPLANATION OF PLATE SEE PAGE 636.



SKELETON BONES OF EPIGAULUS HATCHERI.

FOR EXPLANATION OF PLATE SEE PAGE 636.



VERTEBRAL COLUMN AND PELVIS OF EPIGAULUS HATCHERI.

FOR EXPLANATION OF PLATE SEE PAGE 636.

THE HOLOTHURIANS OF THE HAWAIIAN ISLANDS.

By Walter K. Fisher,
Of Stanford University, California.

INTRODUCTION.

Holothurians or sea cucumbers are fairly plentiful in the tide pools among the lava rocks and on exposed reefs of the Hawaiian Islands and form a very characteristic portion of the more conspicuous shore fauna. They are almost sure to be found by the general naturalist who explores the reef between Honolulu and Waikiki or carries his investigations to remoter parts of the islands among the many pools and inlets that fringe the lava shores. Such forms as *Actinopyga mauritiana*, *Holothuria atra*, *H. fuscorubra*, *H. cinerascens*, *H. pervicax*, *H. pardalis*, *H. impatiens*, and *Stichopus tropicalis* are common, especially the first two, which are large and take no pains to hide themselves. In Pearl Harbor, *Ophiodesoma spectabilis*, which occurs in great numbers, is likely to attract the attention of anyone interested in natural history. Careful and systematic collecting on the reefs and in the tide pools should bring to light many characteristic tropical forms as yet unrecorded from the islands. Care should be taken to turn over large stones and to examine masses of seaweed. One form, at least, *Chiridota hawaiiensis*, lives buried in coral sand.

Holothurians are best preserved in fairly strong alcohol, rather than in formalin, because the latter is likely in time to partially dissolve the minute calcareous bodies which occur in the outer layer of the body wall and which are a necessity for the accurate identification of specimens. To kill the animals in an expanded condition, it is well to first narcotize them by gradually adding to the sea water in which they are contained a quantity of Epsom salts or about an equal volume of ether. The latter should be added gradually after the animals are expanded. When they are thoroughly numbed, they may be placed in about 60 per cent alcohol and after a few hours transferred to 90 per cent. Chloretone is a good narcotizing agent, but is expensive. Some species are so sensitive that acid reagents must be resorted to in

order to kill them in an expanded state. Glacial acetic acid serves very well. Acid, however, must be carefully avoided if it is intended to use the specimens for systematic purposes, because the absence of calcareous deposits in the skin usually renders exact determination impossible. If there is a possibility of acid being present in the alcohol, add to the bottle a small portion of bicarbonate of soda or some other harmless neutralizing agent.

It is necessary to use a compound microscope in the examination of holothurians, in order to determine the character of the calcareous deposits in the skin. In the case of most synaptids and related forms it is necessary merely to soak a piece of the body wall for a few moments in strong caustic potash solution and then mount it in glycerin, which further clears the tissues. Permanent mounts are conveniently made in glycerin jelly. Many holothurians, however, have so thick a body wall that only the outer pigmented layer should be taken. Often it is necessary to boil a piece of the skin in caustic potash, especially when there is considerable pigment and one wishes to free the deposits of encumbering tissue in order to draw or photograph them. Deposits are frequently so closely crowded in the perisome that unless they are freed of tissue and spread out on a slide it is impossible to gain an idea of their true character.

The holothurians collected by the United States fisheries steamer *Albatross* among the Hawaiian Islands during the summer of 1902 proved to be less numerous in species than the collection of starfishes.[a] Nor were there so many individuals. The entire collection numbers about 750 specimens and includes 37 species, of which 19 are new to science, 5 are for the first time recorded from the Hawaiian group and 2 are in too poor condition for naming beyond the genus. The United States fisheries steamer *Albatross* secured 11 forms already reported from the islands, but failed to find 9 species known to occur in the region. The Hawaiian fauna therefore includes 44 species of holothurians, of which only 20 were known previous to the visit of the fisheries steamer *Albatross*. To these may be added the two forms which are too imperfect to be identified specifically, making a total of 46 species.

The shore and reef fauna is unmistakably tropical. Excluding those littoral forms which appear to be confined to the Hawaiian Islands, namely, *Actinopyga obesa*, *Holothuria paradoxa*, *H. kapiolanix*, *H. humilis*, *H. hawaiiensis*, new species, *H. anulifera*, new species, *H. fusco-olivacea*, new species, *Opheodesoma spectabilis*,[b] new species, and *Chiridota hawaiiensis*,[c] new species, there remains a group of forms

[a] See U. S. Fish Commission Bulletin for 1903, Pt. 2, pp. 897 to 1130, June 30, 1906.

[b] Closely related to *Opheodesoma glabra* (Fiji Islands, Bohol, Guam, Saleyer, Bima).

[c] Near *Chiridota rigida*.

which are either cosmopolitan in tropical and semitropical waters or widely distributed over the warmer parts of the Pacific and Indian are oceans. The practically cosmopolitan forms are: *Actinopyga parrula*, *Holothuria impatiens*, and *Holothuria atra*, these being found in the Atlantic, Pacific, and Indian oceans. A general idea of the distribution of the remaining shore forms may be gained from the following table:

Distribution of shore forms of Holothurians.

Species.	Indian Ocean.	Indo-Chinese region (East Indies, Philippines, etc.).	Chinese-Japanese region.	South Sea (Polynesia, Micronesia, Melanesia).	Australia.	West coast of Middle and South America.
Actinopyga nobilis	×	×		×		
Actinopyga mauritiana						
Holothuria cinerascens						
Holothuria perrieri						
Holothuria monacaria	×	×		×	×	
Holothuria vagabunda						
Holothuria fuscorubra		×		×		
Holothuria arenicola[a]						
Holothuria pardalis						
Holothuria inhabilis				[b]		
Holothuria verrucosa						
Labidodemas semperianum		×		×		
Stichopus chloronotus						
Stichopus tropicalis						
Squamodota kelaerti						
Euapta godeffroyi						

[a] Also reported from north and east coasts of South America.

[b] Society Islands.

It is hazardous to undertake to do more than indicate in a general way the relationships of the bathybial fauna, because some of the species are obscure and the identification of their nearest relatives is almost a matter of assumption. It is probably true that we have not, as yet, sufficient data upon which to map with any degree of accuracy the faunal relationships of deep-sea holothurians. The bottom of the ocean has been no more than scratched in a few places. Such forms as *Bathyplotes patagiatus*, *Pelopatides retifer*, *Scotodeima vitreum*, and *Lætmogone biserialis* appear to find their nearest relatives in the deep waters of the East Indies. *Orphnurgus insignis* has a related species in the Bay of Bengal (*O. glaber* Walsh), and another (*O. aspera* Théel) in the West Indies (Sombrero, British West Indies). *Mesothuria carnosa* shows great similarity in most of its characters to *M. intestinalis* of northern Europe, and *M. verrilli* of the Azores and warmer waters of Europe. *Pannychia pallida* is closely related to *P. moseleyi* of Australia and *Protankyra albatrossi* to *P. challengeri* of the Fiji Islands. *Pseudostichopus propinquus* seems nearest *Pseudostichopus mollis*, from Marion Island, southern Indian Ocean, and from the west coast of South America, near the southern end. *Anapta inermis* is distantly related to *A. subtilis*, bay of Batavia, and *Chiridota*

uniserialis to *C. purpurea* and *C. pisanii* from the Falkland Islands and Chonos Archipelago, respectively. Dredging was not carried into water deep enough to secure many of the characteristic abyssal types which undoubtedly must occur in the region. Only two of the deep-water forms are referable to previously known species. These are *Mesothuria murrayi* and *M. parva*, the former having been taken in the East Indies, near the Azores, off the Straits of Gibraltar, and near Juan Fernandez, and the latter from near Admiralty Island.

SYNOPSIS OF HAWAIIAN HOLOTHURIANS.

(Those marked with an asterisk (*) were not taken by the Albatross expedition.)

Order **ACTINOPODA** Ludwig.

Family HOLOTHURIIDÆ Ludwig.

Subfamily HOLOTHURIINÆ Ludwig.

Genus *Actinopyga* Bronn.

Actinopyga parvula (Selenka).
*nobilis** (Selenka).
obesa (Selenka).
mauritiana (Quoy and Gaimard).

Genus *Holothuria* Linnæus.

Holothuria paradoxa (Selenka).
*kapiolanix** (Bell).
cinerascens (Brandt).
pervicax Selenka.
atra Jäger.
*monacaria** (Lesson).
*vagabunda** Selenka.
*humilis** Selenka.
fusco-rubra Théel.
arenicola Semper.
pardalis Selenka.
*inhabilis** Selenka.
impatiens (Forskål).
*verrucosa** Selenka.
hawaiiensis, new species.
anulifera, new species.
fusco-olivacea, new species.

Genus *Labidodemas* Selenka.

*Labidodemas semperianum** Selenka.

Genus *Stichopus* Brandt.

Stichopus chloronotos Brandt.
tropicalis, new name.

Subfamily SYNALLACTINÆ Ludwig.

Genus *Mesothuria* Ludwig.

Mesothuria carnosa, new species.
murrayi (Théel).
parva (Théel).

Genus *Bathyplotes* Östergren.

Bathyplotes patagiatus, new species.

Genus *Pseudostichopus* Théel.
Pseudostichopus propinquus, new species.
Genus *Pælopatides* Théel.
Pælopatides retifer, new species.

Family ELPIDIIDÆ Théel.

Subfamily DEIMATINÆ (Théel) Ludwig.
Genus *Scotodeima* Ludwig.
Scotodeima vitreum, new species.
Genus *Orphnurgus* Théel.
Orphnurgus insignis, new species.
Genus *Lætmogone* Théel.
Lætmogone biserialis, new species.
Lætmogone, species.
Genus *Pannychia* Théel.
Pannychia pallida, new species.

Family CUCUMARIIDÆ Ludwig.

Subfamily CUCUMARIINÆ R. Perrier.
Genus *Thyonidium* Düben and Koren.
Thyonidium hawaiiense, new species.
alexandri, new species.
Subfamily PSOLINÆ R. Perrier.
Genus *Psolus* Oken.
Psolus macrolepis, new species.

Order **PARACTINOPODA** Ludwig.

Family SYNAPTIDÆ Burmeister.

Genus *Synaptula* Örsted.
Synaptula kefersteinii (Selenka).
Genus *Euapta* Östergren.
Euapta godeffroyi (Semper).
Genus *Opheodesoma*, new genus.
Opheodesoma spectabilis, new species.
Genus *Protankyra* Östergren.
Protankyra albatrossi, new species.
Genus *Anapta* Semper.
Anapta inermis, new species.
Genus *Chiridota* Eschscholtz.
Chiridota hawaiiensis, new species.
uniserialis, new species.
Genus *Taeniogyrus* Semper.
Taeniogyrus, species.

The nineteen species believed to be new are as follows:

Holothuria hawaiiensis.
Holothuria amulifera.
Holothuria fusco-olivacea.
Mesothuria carnosa.
Bathyplotes patagiatus.
Pseudostichopus propinquus.
Pælopatides retifer.
Scotodeima vitreum.
Orphnurgus insignis.
Lætmogone biserialis.
Pannychia pallida.
Thyonidium hawaiiense.
Thyonidium alexandri.
Psolus macrolepis.
Opheodesoma spectabilis.
Protankyra albatrossi.
Anapta inermis.
Chiridota uniserialis.
Chiridota hawaiiensis.

A new name, *Stichopus tropicalis*, is used to replace "*Stichopus godeffroyi*, variety b," this so-called variety being here considered a distinct species, as explained in the description of that form.

Species previously known but now for the first time recorded from the Hawaiian group are:

Actinopyga parvula.
Holothuria arenicola.
Mesothuria murrayi.
Mesothuria parva.
Euapta godeffroyi.

Previously reported species secured by the fisheries steamer *Albatross:*

Actinopyga obesa.
Actinopyga mauritiana.
Holothuria paradoxa.
Holothuria cinerasens.
Holothuria pervicax.
Holothuria atra.
Holothuria fusco-rubra.
Holothuria pardalis.
Holothuria impatiens.
Stichopus tropicalis.
(=*Stichopus godeffroyi* var. b, of authors.)
Synaptula kefersteinii.

Species recorded from the Hawaiian Islands, but not taken by the fisheries steamer *Albatross:*

Actinopyga nobilis.
Holothuria kapiolaniæ.
Holothuria monacaria.
Holothuria vagabunda.
Holothuria humilis.
Holothuria inhabilis.
Holothuria verrucosa.
Labidodemas semperianum.
Stichopus chloronotos.

All the known species of Hawaiian holothurians have been included in the keys in this report, and short diagnoses of those not taken by the fisheries steamer *Albatross* are inserted in the proper place, but are marked in all cases by an asterisk (*). It is believed that this method will render the report more useful to the general naturalist, since literature on the subject is often inaccessible. The various lists will prevent confusion concerning the species actually secured by the expedition of 1902.

I wish to acknowledge my indebtedness to Mr. Wilfred H. Osgood, of the Bureau of Biological Survey, and to Miss Mary J. Rathbun, of the U. S. National Museum, for looking up references which were not accessible to me; and to Dr C. H. Gilbert, of Stanford University, and Dr. Hubert Lyman Clark, of the Museum of Comparative Zoölogy, for advice on several matters. Dr. Clark has also kindly looked over the page proofs.

While correcting the galley proofs I received Kœhler and Vaney's important memoir entitled An Account of the Deep-Sea Holothuriodea collected by the Royal Indian marine survey ship *Investigator*. So far as possible I have taken account of Kœhler and Vaney's species in the descriptions of the *Albatross* material. It has not, at this late hour, been possible to accord to this work the space and attention that it deserves.

DESCRIPTION OF SPECIES.

Class HOLOTHURIOIDEA.

KEY TO FAMILIES AND GENERA OF HAWAIIAN HOLOTHURIOIDEA.

a. With pedicels or papillæ or both. All ambulacral appendages arise from the radial canals, appearing as a circle of tentacles about the mouth, and as pedicels or papillæ, or both, over rest of body.....Order ACTINOPODA.

b. Tentacles more or less peltate. No retractor muscles.

c. Respiratory trees present.....HOLOTHURIIDÆ.

d. Tentacle ampullæ well developed. Madreporic canals often numerous, never attached to body wall. Vascular system forming a rete mirabile in connection with left respiratory tree.....HOLOTHURIINÆ.

e. Genital tubes in a tuft on left side of dorsal mesentery.

f. Anal teeth present.....ACTINOPYGA.

ff. Anal teeth absent.

g. Ambulacral appendages scattered over whole body and usually without arrangement in rows; less commonly arranged in longitudinal bands on ventral surface.....HOLOTHURIA.

gg. Ambulacral appendages only on the radii, and in double rows.

LABIDODEMAS.

ee. Gonad in a right and left tuft, no anal teeth; pedicels on the 3d ventral radii, mostly in longitudinal bands. Dorsal surface with papillæ, often on warts.....STICHOPUS.

dd. No free tentacle ampullæ. Madreporic canal single and usually in connection with body wall; only exceptionally a rete mirabile present.

SYNALLACTINÆ.

e. Genital tubes only in a left tuft. Anus not in a vertical furrow. Ventral surface somewhat flattened. Ambulacral appendages in form of many small scattered pedicels, usually largest on lateral ventral ambulacra.

MESOTHURIA.

ee. Gonad in a right and left tuft.

f. Anus in a vertical furrow. Pedicels and papillæ unusually small, those of dorsum nearly rudimentary; pedicels of lateral ventral ambulacra more prominent than rest. Deposits often wanting.

PSEUDOSTICHOPUS.

ff. Anus not in a furrow, terminal or subdorsal. Body more or less depressed, usually with a border or brim.

g. C-shaped deposits present.....BATHYPLOTES.

gg. No C-shaped deposits. Pedicels only on middle and hinder part of midventral radius; deposits often wanting.....PELOPATIDES.

cc. Respiratory trees absent. No rete mirabile. No tentacle ampullæ. Dorsal surface with large papillæ, ventral with very large pedicels, always in rows. Madreporic canal opening to exterior. Deep-sea forms.....ELPIDIIDÆ.

d. In the stiff skin neither wheels nor tables. Above the pedicels of lateral ventral radii a series of large flank-papillæ.

e. Pedicels of ventrolateral radii in two series; remarkably long flank and dorsal papillæ; papillæ of dorsal radii in two series; deposits very large X and Y shaped rods, and in papillæ very long simple rods perforated at tips. Anus ventral.....SCOTODEIMA.

ee. Pedicels of ventrolateral radii in a single series, those of dorsal in either one or two series. Deposits, large crowded spiny rods and spiny ellipsoids.....ORPHNURGUS.

dd. Skin more pliable, with many wheels. Flank papillæ small or absent.

e. Midventral radius without pedicels.....LÆTMOGONE.

ee. Midventral radius with two rows of pedicels.....PANNYCHIA.

bb. Tentacles dendroid. Retractor muscles present.....CUCUMARIIDÆ.

c. Tentacles 20, five pairs of large alternating with five pairs of very much smaller ones. No large scales on dorsal surface, which always has scattered pedicels.....THYONIDIUM.

cc. Tentacles 10; ventral surface flattened, forming a creeping sole on which pedicles are arranged in two or three longitudinal bands. Dorsal surface with large scale-like plates which imbricate; no dorsal pedicels. Mouth and anus dorsal, often guarded by large plates or valves.....PSOLUS.

aa. No pedicels or papillæ, and no respiratory trees. Tentacles arise only partly from radial canals, and partly from ring canal.

Order PARACTINOPODA, SYNAPTIDÆ.

b. Calcareous deposits in the skin consisting of anchors and perforated plates.

c. Anchor arms smooth, without serrations; vertex with minute knobs; anchor plates symmetrical.

d. Handle of anchors with branches; cartilaginous ring absent, or present.

e. Calcareous ring without anterior projections; madreporic canal single (never many); cartilaginous ring absent; handle of anchor plates with 2 large and several small smooth holes.....EUAPTA.

ee. Calcareous ring with conspicuous anterior projections; numerous madreporic bodies; cartilaginous ring sometimes present; 2 large holes in handle of anchor plates absent.....OPHEODESOMA.

dd. Cartilaginous ring present; handle of anchor without branches.

SYNAPTULA.

cc. Arms of anchor usually serrate; anchor plates asymmetrical, the circumference uneven or incomplete; not narrowed into a handle; tentacles digitate.....PROTANKYRA.

bb. Calcareous deposits never anchors and plates, but wheels with six spokes, S-shaped rods, small C-shaped rods or simple rods, sometimes oval grains; sometimes wanting.

c. Deposits absent (sometimes present as oval grains).....ANAPTA.

cc. In addition to wheels collected in little heaps, often small curved, C-shaped, or straight rods, smooth, rough, or parted at tips; no sigmoid bodies.

CHIRIDOTA.

ccc. Sigmoid rods present; sometimes also wheels, either in heaps or scattered.

TÆNIOGYRUS.

Order ACTINOPODA Ludwig, 1891.

Family HOLOTHURIIDÆ Ludwig.

Holothuriidæ LUDWIG, Mem. Mus. Comp. Zool., XVII, 1894, p. 7.

Subfamily HOLOTHURIINÆ Ludwig.

Genus ACTINOPYGA Bronn.

Mülleria[a] JÄGER, Dissertatio de Holothuriis, 1833.

Actinopyga BRONN, Klassen u. Ordnungen des Thierreichs, 1860.

[a] Notwithstanding the fact that *Mülleria* Jäger is at least three times preoccupied (Férussac, 1823, mollusca; Desmarest, 1825, crustacea; Fleming, 1828, echinoderma, according to Agassiz's Index Universalis), some of the leading authorities still employ the name, although Professor Bell pointed out the error in Ann. Nat. His., (5) XX, p. 148.

The following is Théel's description:

Tentacles 20 to 27. Ambulacral appendages in the shape of pedicels on the ventral surface and papillæ on the dorsal. Seldom an arrangement of pedicels in longitudinal series visible. A single genital bundle present, situated on left side of dorsal mesentery. Anus surrounded by five calcareous teeth. No C-shaped deposits in the body wall.

KEY TO HAWAIIAN SPECIES OF ACTINOPYGA.

a. Among the deposits, tables.

b. Tentacles 20; calcareous deposits crowded tables (the spire of which is truncate, quadrate, armed with numerous teeth) and large, smooth buttons with six to eight holes ordinarily, but exceptionally four or five and as high as thirteen. *parvula.*

bb. Tentacles 20; calcareous deposits thinly scattered tables, the spire terminating in sixteen to twenty teeth, and hollow fenestrated ellipsoids forming a thick layer ..... *mobilis.*

aa. Deposits chiefly rods; no tables.

b. Tentacles 20; deposits finely granulated, simple rods ..... *obesa.*

bb. Tentacles 25; deposits in dorsal integument rods, with small processes running out at the sides and with ends spinous or dichotomous; in the ventral perisome small, smooth, oval grains and larger, smooth, unbranched rods with the ends slightly rough ..... *mauritiana.*

ACTINOPYGA PARVULA (Selenka).

Plate LXVII, figs. 2, 2*a–g.*

Mülleria parvula Selenka, Beiträge zur Anatomie u. Systematik der Holothurien, Zeitschr. f. Wiss. Zool., XVII, 1867, p. 314, pl. xvii, figs. 17–18.

Body elongate ovoid, robust, but much contracted. Tentacles retracted, but mouth apparently somewhat ventral; anus terminal, surrounded by five small calcareous teeth. Tentacles 20 to 21, peltate, medium sized, rather crowded. Ventral surface well marked from dorsal, covered with pedicels of conspicuous size which are not arranged in definite order. Papillæ of dorsum much less numerous, without order, and contracted so that their size is not at once apparent. They seem to be slightly smaller than the pedicels and are without terminal plates. Integument thick, minutely roughened by the spires of the densely crowded tables. Deposits: Very numerous tables and buttons; the former with a central and about eight peripheral smaller holes and a well-developed spire terminating in a subquadrate crown of numerous (about thirty-six) teeth; the latter large, smooth, pierced by six to eight irregular holes. Pedicels and papillæ with perforated supporting plates and rods. The color in alcohol is very dark brown. Length of largest individual, much contracted, 40 mm.; width, 28 mm.

Localities.—Napili, Maui (2); Necker Island? (6); Honolulu, reef (2); Laysan, reef (3).

Although the specimens are badly contracted it is evident that the crown of tentacles is surrounded by a collar, perhaps not so prominent

as in *A. mauritiana*. The pedicels continue to the very edge of the collar, on which the papillæ are larger than over rest of dorsum. Superficially the retracted papillæ resemble pedicels, but since there appears to be no perforated terminal plate such as is well developed in the pedicels, they are not to be ranked with the latter. The supporting rods and plates are, however, well developed toward the top of the papillæ. (See below.)

The calcareous ring has no posterior prolongations, but anteriorly is deeply scalloped. The exact shape is best shown by the figure. (Plate LXVII, fig. 2*g*.) There are two large Polian vesicles and one short, twisted, madreporic canal embedded in the dorsal mesentery. The madreporic body is prominent and lies on the left side of the mesentery. The gonad is still small, and forms a tuft on the left side of the mesentery, behind the madreporic canal. Left branch of respiratory tree much longer than right. Cuvierian organs relatively large.

Both tables and buttons are very numerous in the perisome, the edges of the former overlapping, or at least touching. The buttons which lie beneath the tables also imbricate irregularly. The disk of the tables is 0.08 to 0.09 mm. in diameter and is pierced by eight peripheral holes and a central larger one. Frequently there are several small accessory perforations. Rim is smooth, slightly undulating; the spire is robust, and is made up of four upright pieces slightly flaring at the crown, which is armed with numerous teeth, whose arrangement is best shown by the figures. Buttons are large, smooth, and vary considerably in size, but average 0.1 mm. in length. They are broadly elliptical and the six or eight holes are rather small in proportion to the whole button. Many of the buttons are rather wider in proportion to length than the figures here given. Some buttons have five holes, and a few four or nine. Occasionally a button is incomplete, a portion of the outer rim being wanting. Supporting rods and plates, two types of which are figured (Plate LXVII, fig. 2*f*), are abundant in the walls of the pedicels and papillæ, where also tables are present. The rods and plates grade into large buttons in the proximal portion of the pedicels and papillæ. In the pedicels the plates are more abundant than the supporting rods and are slightly larger than those in the papillæ, averaging 0.15 to 0.20 mm. longest dimension, although smaller ones are present. There are also very large buttons in the pedicels with twelve or thirteen holes. The terminal perforated plate of the pedicels is well developed and measures 0.5 mm. in diameter, the perforations about 0.015 mm.

This species is a shore form, inhabiting tide pools in lava rock and on coral reefs. Since the gonad is still very small the specimens are probably immature, as their size would suggest. This wide ranging form, which Bedford[a] believes includes *flavocastanea*, is found in

[a] Proc. Zool. Soc., 1898.

the Atlantic (Florida, Madeira), Red Sea (Kosseir), and over the greater part of the Indo-Pacific region (Seychelles Islands to Samoan, and Hawaiian Islands.)

* ACTINOPYGA NOBILIS (Selenka).

Holothuria (subgen. *Microthele*) *maculata* BRANDT, Prodr., 1835, p. 54. (Not to be confused with *Sporadipus* (*Acolpos*) *maculatus* Brandt, Prodr., 1835, p. 46, which is *Holothuria arenicola* Semper.)

Mülleria nobilis SELENKA, Zeit. für Wiss. Zoologie, XVII, 1867, p. 313, pl. XVII, figs. 13–15.

This species is attributed to the Hawaiian Islands by Selenka, but is not present in the collection brought home by the fisheries steamer *Albatross*. The following diagnosis is from Théel's monograph, page 198:

Color almost black, speckled with lighter tint. Dorsal papillæ more thinly scattered than the ventral pedicels, and of about the same size or smaller than these. In the contracted state the dorsal surface seems to have some low protuberances, especially along the sides of the body. The anal teeth are small and surrounded by five groups of papillæ, each group corresponding in position with a tooth. The tables are thinly scattered, consisting of an irregularly rounded disk with smooth undulated margin and pierced by a large central and several smaller peripheral holes; the spire, formed by four rods and one transverse beam, terminates in twenty or more teeth. (Teeth as few as 16.) The hollow fenestrated ellipsoids form a thick layer.

ACTINOPYGA OBESA (Selenka).

Plate LXVII, fig. 3.

Mülleria obesa SELENKA, Beiträge zur Anatomie u. Systematik der Holothurien, Zeitschr. für Wiss. Zool., XVII, 1867, p. 312

General form robust, oblong, blunt[a] at both ends. Mouth ventrally turned, probably not always so, as in some much contracted individuals it appears terminal. Anus terminal, surrounded by five calcareous teeth. Tentacles 20, rather broadly peltate. Ventral surface covered with numerous pedicels which are for the most part retracted within the body, but which appear to form three indefinite rows. Papillæ scattered (entirely retracted), less numerous than pedicels. Perisome thick and leathery. Deposits: Rather finely granulated simple rods. Color in alcohol, dark chestnut-brown. Largest contracted specimen 180 mm. long and about 70 to 80 mm. broad.

Locality.—Laysan Island (7 specimens).

All the specimens are too much contracted to furnish any details as to general habit. The tentacles seem to vary from 19 to 21. As indicated in the diagnosis the pedicels are mostly withdrawn. By slicing off a thin layer of the ventral surface the dark pigment is removed, and in the largest specimens the pedicels appear to be more crowded

[a] This species was not observed in the living state, and all the specimens are badly contracted. The general shape is evidently similar to that of *M. mauritiana*.

along a median longitudinal and two lateral areas, although these areas do not appear sharply defined by any means.

In the large specimen dissected there is but one madreporic canal, situated on the right side of the mesentery. The madreporic body is elongate (6 mm.) and is perfectly free in the body cavity. There is but one Polian vesicle. Calcareous ring without posterior prolongations. The radial pieces are considerably larger than the interradial. Genital glands form a large tuft on the left side of the dorsal mesentery. Right branch of respiratory tree longer than left, reaching to calcareous ring. Cuvierian organs present at left side of base of respiratory tree; tuft rather small.

The calcareous deposits are numerous but of a simple nature, consisting of straight or slightly curved, rather finely granulated rods, the granulations assuming the form of irregular protuberances at the ends. In the dorsal perisome the rods average slightly larger than in the ventral. They vary from 0.08 to 0.12 mm., the former being the average. Many are as small as 0.05 mm., and the smallest are about 0.03. Occasionally the rods are forked slightly at one or both ends. The rods of the ventral perisome average between 0.05 and 0.07 mm.

This species is apparently confined to the Hawaiian group. No specimens, however, were taken in the Windward Islands, where it is likely the type was secured.

ACTINOPYGA MAURITIANA (Quoy and Gaimard).

Plate LXVII, figs. 1, 1*a–d*.

Holothuria mauritiana Quoy and Gaimard, Voyage de l'Astrolabe Zoologie, IV, Zoophytes, 1833, p. 138.

Body elongate, robust, broadest posteriorly, or sometimes nearer middle, usually slightly constricted near anterior end. Mouth usually distinctly ventral, surrounded in life by a conspicuous, papillose collar. Anus terminal, with five white calcareous teeth. Tentacles about twenty-five (twenty-two to twenty-six), rather crowded, broadly peltate, the crests arranged in two irregular, concentric rows. Peristome broad. Pedicels densely crowded, and without order, confined to the flattish ventral surface. Dorsal papillæ much fewer than pedicels, about the same size and irregularly scattered. Integument tough and leathery. Deposits: In the dorsal integument longer and shorter rods, with small processes along the sides and with the ends dichotomous or spinous, together with numerous, much smaller rosettes, usually not very intricate; in the ventral perisome small, smooth, oval grains and larger unbranched rods with the ends slightly roughened. Ventral deposits much more numerous than dorsal. Color variable, usually an olivaceous brown, the bases of the papillæ encircled with whitish; blotched with whitish along the sides and distad (see p. 649).

Largest preserved specimen 165 mm. long, 50 mm. wide, 45 mm. dorso-ventrally.

Localities.—Tide pools in Puako Bay, Hawaii; Kealakekua Bay, Hawaii; Kamalino Bay, Niihau; Napili, Maui; Waialua, Oahu. Twenty-seven specimens.

It is apparently characteristic of this species to have the mouth open ventrally. The broad collar which surrounds it is always much contracted in the preserved specimens. The difference between the ventral surface, which is rather flat, and the dorsal, which is well arched, is very conspicuous and is heightened by a difference of color. The pedicels extend to within 15 to 20 mm. of the rim of the circumoral collar or ruff, and to within 8 to 10 mm. of the anal aperture. The papillæ are more numerous in some specimens than others, but tend to become rather more crowded toward the anus, and along the sides of the body adjacent to the pedicels, where they are also larger. The papillæ are also longer on the collar, particularly on its rim. The numerous specimens which belong to this species vary considerably in the shade of brown and in the amount of white. The more usual coloration is a rich raw umber. An unspotted individual had the dorsum deep olive brown, the ventral surface light pinkish brown; tube feet raw umber; tentacles greenish brown or raw umber translucent, with grayish effects in some lights. Near Kealakekua Bay, Hawaii, I collected one large specimen which is decidedly dark and spotted. An example from Kamalino Bay, Niihau, is light olivaceous brown, heavily blotched on the sides with white and with all the dorsal papillæ encircled with white.

Calcareous ring rather massive. There is scarcely any difference in size between the radial and interradial pieces. Ampullæ of tentacles long. Polian vesicles two. There are three madreporic bodies to the left of the dorsal mesentery, free in body cavity. One madreporic canal is usually much longer than the other two, more or less convoluted, and frequently is median in position, lying in the dorsal mesentery. Gonads form one cluster, resembling a swab of hempen tangles, on the left side of the mesentery. Right respiratory tree reaching to calcareous ring, left only half as long, but more bushy. Cuvierian organs present, forming a tuft to the left of the base of the respiratory tree.

The rods in dorsal perisome vary considerably in shape in the same individuals, the principal types being figured. They vary in length from 0.08 to 0.14 mm., or are sometimes even longer. The rosettes average from 0.02 to 0.03 mm., and are scattered among the rods. They are congregated, however, in dense masses about the base of the papillæ, giving the whitish color characteristic of some specimens. Consequently in those specimens having considerable whitish on the body, the rosettes are very numerous. A few of the larger papillæ

appear to possess rudimentary terminal plates, but the greater number show no trace of them. The rods in the walls of the papillæ are very few. The deposits in the ventral perisome, in the form of smooth oval grains and unbranched rods, are highly characteristic, and occur in great numbers, forming several layers. The rods are rather more numerous near the bases of the pedicels, which possess well-developed perforated terminal plates, but no supporting rods in the walls. Sometimes, however, a few grains are present near the end, and a few rods also. The grains vary considerably in size, ranging from 0.01 to 0.04 mm. in length. The rods do not generally exceed 0.1 mm. in length. Rosettes are not present in the ventral perisome of all the specimens. Théel found them present in examples from the Samoan, Fiji, and other islands of the South Seas. I find them fairly numerous in a medium-sized, dark, sparsely spotted specimen from Puako Bay, Hawaii, but in larger individuals with spots, from the same locality, they appear to be almost if not entirely wanting.

This species is found in tide pools in the lava rock, especially on the coast of Hawaii. We did not take any on coral reefs. It is one of the commonest and most characteristic invertebrate forms of the shore fauna, and does not take any special pains to hide itself.

Genus HOLOTHURIA Linnæus.

Holothuria Linnæus, Systema Naturæ, 10th ed., 1758.

The following description of the genus is taken from Théel:

Tentacles 20, exceptionally more or less. Ambulacral appendages, pedicels alone, papillæ alone, or both papillæ and pedicels; the papillæ placed on the dorsal surface, the pedicels on the ventral. These ventral pedicels are seldom arranged in longitudinal series. A single bundle of genital tubes placed on left side of dorsal mesentery. Anus devoid of calcareous teeth, but sometimes stellate. C-shaped deposits absent.

KEY TO HAWAIIAN SPECIES OF HOLOTHURIA.

a. Deposits simple or branched rods, the branches being sometimes united, the rods then acquiring the shape of irregular perforated plates; no tables.

b. In dorsal perisome branched X-shaped rods; in ventral, smooth rods in addition; the arms of X-shaped bodies branched and often united; one Polian vesicle. *paradoxa.*

bb. Deposits in the form of delicate, slightly curved, very spiny rods; two Polian vesicles ..... *kapiolaniæ.*

aa. Among the deposits, tables.

b. Tables and rods or irregular perforated plates, but no buttons.

c. Rods but no plates.

d. Tables with annular disk together with large rods branched at tips and covered with many small protuberances or granulations ..... *cinerascens.*

dd. Spire of tables often reduced. The small, more or less elongate rods are characterized by being uneven, warted, distinctly undulated, or deeply incised so as to form a row of loops or holes along each side ..... *pervicax.*

cc. In addition to tables with small annular disk and twelve teeth to crown of spire, small fenestrated plates, or branched X-shaped bodies. Blackish, and large in life ..... *atra.*

bb. Tables and buttons.
c. Buttons smooth, without knobs, granulations, or elevations on surface.
d. Buttons irregular, and occasionally more or less incomplete, often reduced to rods resembling central shaft of buttons.
e. Tentacles 20. Tables with one cross-beam to spire.
f. Buttons never complete; really flat rods irregular or deeply incised on sides; disk of table with smooth margin ..... *pervicax.*
ff. Most of buttons complete, many fairly regular. Disk of table with spinous rim.
g. Buttons accumulated in rings in integument, two rows of dark spots along dorsal surface ..... *pardalis.*
gg. Buttons scattered. Reddish brown to purplish brown, unspotted. *fusco-rubra.*
ee. Tentacles 30. Tables with one to three cross-beams to spire. *hawaiiensis.*
dd. Buttons regular.
e. Tables with four uprights and one beam to spire.
f. Disks of tables with smooth or undulating but not spinous margin.
g. Crown of spire ending in eight to ten teeth. Pedicels only.
h. Calcareous ring very small, with ten small, brown, round pieces. *humilis.*
hh. Calcareous ring of usual shape ..... *vagabunda.*
gg. Crown of spire ending in more than ten teeth.
h. Pedicels and papillæ arranged in series. Crown of spire ending in usually more than ten and less than twenty teeth ..... *monacaria.*
hh. Pedicels alone; arranged more or less in series. Spires terminating in more than twenty teeth. Two rows of dark reddish brown spots on back, in contrast to light skin ..... *arenicola*
ff. Disks of tables spinous on margin.
g. Buttons partly irregular, accumulated in rings ..... *pardalis.*
gg. Buttons all regular.
h. Only pedicels (a few tables with spinous disk) ..... *vagabunda.*
hh. Only papillæ ..... *verrucosa.*
ee. Many of tables with two cross-beams to spire. Buttons very regular. Only pedicel-like papillæ ..... *impatiens.*
cc. Buttons with granulations, knobs, or elevations on surface; not smooth. Disk of tables more or less spinous on margin.
d. Buttons all complete.
e. No supporting rods to pedicels, which are all over body. The solid tables with twelve spines on margin. Buttons uneven with flattened elevations on surface, margin deeply undulated ..... *inhabilis.*
ee. Papillæ on dorsal surface, pedicels on ventral, both with large smooth supporting rods having spinous edge. Tables of two kinds. Buttons variable in size, covered with numerous granulations ..... *fusco-olivacea.*
dd. A few buttons with comparatively few knobs along edge and central shaft; the rest in form of knobby incomplete buttons, warty rods, or even small +-shaped rods with ends very knobby ..... *anulifera.*

HOLOTHURIA PARADOXA Selenka.

Plate LXVII, figs. 4, 4*a*–*b*, 5; Plate LXIX, fig. 5.

Holothuria paradoxa SELENKA, Beiträge zur Anatomie u. Systematik der Holothurien, Zeitschr. f. Wiss. Zool., XVII, 1867, p. 322, pl. XVIII, fig. 41.

Size large; general form robust, subcylindrical; mouth directed ventrally, although retracted within collar; anus stellate, with five groups of papillæ (much expanded in specimen on account of mass of Cuvierian organs). Tentacles 19, fairly large, but much contracted, apparently surrounded in life by a papillose collar. Ambulacral appendages in the form of numerous pedicels; rather more numerous on ventral than on dorsal surface. Pedicels are without order and are fairly evenly distributed all over body with the exception of a narrow band along each radius of the dorsal surface and the mid-ventral; the two lateral radii are not so distinguished. Body wall thick. Color in alcohol, ventral surface greenish yellow; dorsal the same, verging upon raw sienna, but the pedicels and a circle around the base rather dark brown. This gives the dorsal surface a decidedly brownish appearance which renders the two surfaces easily distinguishable. Deposits: In the dorsal perisome dichotomously branched rods of small size, forming frequently more or less incomplete rosettes; in the ventral perisome simpler, rather stouter smooth rods, branched at the ends, the branches sometimes uniting and forming perforations, occasionally in the form of small plates with two or three perforations (see figures); in the walls of pedicels smooth, slightly curved supporting rods with branches or processes at the ends are present. Length, in a much contracted state, 250 mm.; width, about 65 mm.

Locality.—Station 3847, south coast of Molokai Island, 23 fathoms, sand and stones; 1 specimen.

Among pedicels of dorsum are somewhat larger conical appendages, with rudimentary terminal plate, which must be regarded as papillæ. They are very much less numerous than the pedicels. As indicated in the diagnosis, there is no bare streak separating the ventral pedicels from the lateral, but the two surfaces simply are continuous. The difference in color and in number of pedicels serves to indicate the transition.

Calcareous ring massive and of the usual shape; radial pieces larger than the interradial, but only a trifle broader on the posterior margin. They are 12 mm. long and of about the same width. The interradial pieces are 10 mm. long and 7 mm. wide, and as usual are excavated on the posterior margin. Polian vesicle single. Tentacular ampullæ long. Madreporic canal small, embedded in the dorsal mesentery. Branches of gonad fine, thread-like, and long. Respiratory tree with

left branch in relation with rete mirabile of intestine. Cuvierian organs large; having been ejected it is difficult to determine whether they are divided or not.

The calcareous deposits of the dorsal perisome comprise small rods with the ends several times dichotomously branched and with branches on either side at about the middle. These rods are about 0.041 to 0.046 mm. long, and form incomplete rosettes. Simpler rods are also present, as well as X-shaped bodies. I find no unbranched rods such as are present in the ventral perisome. Here the rods are thicker, simpler, and frequently without any branches whatsoever. Some of the commonest forms are figured. It will be seen from these that occasionally the rods assume the condition of small perforated plates owing to the fact that branches anastomose. I find no rods more complicated than those figured. The supporting rods of the dorsal pedicels average about 0.17 mm. in length. They are smooth and branched simply at the ends. Occasionally a rod will attain 0.29 mm., and I found one perfectly simple which equaled 0.47 mm. The rods of the ventral pedicels are rather smaller, and fewer in number. Toward the base of the dorsal pedicels numerous rather simple small rods, intermediate between the supports and the ordinary variety of the perisome, are present in considerable numbers. The majority of dorsal pedicels have a well-developed terminal plate, nearly if not quite as large as that of the ventral pedicels.

Although the specimen is large, it appears to answer fairly well the requirements of this species. The deposits of *H. vitiensis*, according to Semper's figures, appear to be considerably different. That is apparently the only other form with which this specimen might be confused.

*HOLOTHURIA KAPIOLANIÆ Bell.

Holothuria kapiolaniæ Bell, Proc. Zool. Soc., June 23, 1887, p. 533.

This species is described by Professor Bell, as follows:

Body elongated, soft to the touch, covered with suckers more numerous below than above, scattered quite irregularly; obscurely marked papillæ around the anus. Œsophageal ring of ordinary type, the pieces simple and low, with a rather deep notch posteriorly; stone-canal not remarkably long; two Polian vesicles; genital tubes short, not numerous; Cuvierian organs absent or poorly developed. The spicules merely in the form of delicate, slightly curved, very spiny rods.

Color brownish gray, lighter below, with two rows of eight or nine dark patches on either side of the back. Length 60 mm., average width of 10 mm. Sandwich Islands.

Professor Bell further states that the species "appears to be most closely allied to *H. erinaceus*, from which, however, the much smaller stone-canal and very differently formed spicules are sufficient to distinguish it."

HOLOTHURIA CINERASCENS (Brandt).

Plate LXVIII, figs. 1, 1*a–f*.

Stichopus (*Gymnochirota*) *cinerascens* BRANDT, Prodr., 1835, p. 51.

General form robust, subcylindrical, dorsal and ventral surfaces sharply differentiated, the former with numerous papillæ, rather uniformly spaced, among which some are larger than others; the latter beset with crowded robust pedicels. Anterior end rather broad, the 20 tentacles being robust with large subglobose crowns when fully expanded. The mouth is turned slightly ventrad in life. Posterior extremity of body very blunt; anus surrounded by papillæ. Body wall thick, fairly smooth to the touch. Deposits: Tables, somewhat resembling those of *H. atra*, with a small annular disk (rarely a larger perforated one) and a spire consisting of four rods, one crossbeam, and a crown terminating in eight horizontal and four vertical prominent teeth; numerous slightly curved rods, finely granulated, with the tips frequently slightly branched. Color in life a reddish heliotrope purple to brownish purple; in alcohol, a dull purplish brown, lighter below. Length, about 160 mm.

Localities.—Honolulu Reef (5), Hanalei, Kauai (1), Hilo, Hawaii (1), Puako Bay, Hawaii (1). Eight specimens examined. Of these one is a trifle doubtful on account of absence of calcareous deposits.

There is no sign of any regular arrangement among the pedicels. The papillæ are unequal in size, some being somewhat longer and more pointed than others, which are truncate; the latter, however, may be simply contracted individuals. In one specimen the skin between the papillæ is raised in tiny wartlike eminences, which give the surface a roughened appearance. In a specimen killed with the tentacles fully expanded, the latter are 10 mm. long, and the expanded crowns are 6 to 10 mm. in diameter and almost "arborescent" in appearance. The collar surrounding tentacles is inconspicuous.

Calcareous ring of the usual form. Polian vesicles six in specimen dissected, two being larger than the rest; number reported to be very variable. One madreporic canal is present, on right side of mesentery. The Cuvierian organs are present in specimen examined. Longitudinal muscle bands rather thin. Interior of body cavity yellowish, irregularly spotted with black (alcoholic specimen). Left respiratory tree in relation with rete mirabile of intestine.

The rods are the most characteristic and conspicuous feature of the calcareous deposits. They are very numerous both in the dorsal and ventral perisome, and the supporting rods of the papillæ and pedicels are the same, but in the neighborhood of the terimal perforated plate are smaller. Typically the rods are simple, finely granulated, slightly to considerably curved, with the extremities often branched, or with

coarser tubercles. Occasionally triradiate rods occur, very rarely quadriradiate; again, one end may be considerably expanded and perforated, or along one side there may occur from one to several short "outgrowths" at right angles. The rods vary from 0.1 to 0.3 mm. in length; 0.15 to 0.25 is the commonest average. Tables with a simple annular disk, about 0.04 to 0.06 mm. in diameter, and with or without perforations at the base of the spire supports are most numerous. Rarely larger disks are present, 0.086 mm. in diameter and with twelve to fifteen holes around the rim. The rim of the reduced disks is nearly always very uneven, often irregularly spiney, the spines being short and broad. A few tables with only an incomplete spire are present, the supports branched at the bottom but not joined into a ring. The crown is subquadrate, about 0.045 mm. in diameter over all. The tables resemble those of *Holothuria atra*, but are smaller, the spires being relatively lower. The resemblance lies chiefly in the small disk and twelve teeth. The papillæ have a terminal perforated plate, and the pedicels a somewhat larger one.

This species has a wide distribution, as evidenced by the following localities: Hawaiian Islands, Philippines, Sunda Islands, Java, Tahiti, Batjan and Samoan Islands, Boninsima, Enosima, Mauritius, Seychelles, Zanzibar, Mozambique (Théel, Lampert), and several other intermediate localities. It occurs between tide limits, and on the west coast of Hawaii was found in rock pools. On the reef at Honolulu it occurs in pools near the outer edge, well toward Waikiki.

HOLOTHURIA PERVICAX Selenka.

Plate LXVIII, figs. 2, 2*a–c*.

Holothuria pervicax SELENKA, Beiträge zur Anatomie u. Systematik der Holothurien, Zeitschr. f. Wiss. Zool., XVII, 1867, p. 327, pl. XVIII, fig. 54.

Tentacles nineteen to twenty, usually twenty, with flat yellow crowns. Mouth directed ventrad, the circumoral collar not conspicuous. Dorsal surface arched, with scattered papillæ; the ventral with numerous pedicels which, under favorable conditions, can be seen to form four bands. Each lateral and the two dorsal interambulacra have an irregular series of low (in preserved specimens) tubercles surmounted by a good-sized papilla. The other papillæ are smaller. Body wall moderately thick, the surface smooth to the touch. Deposits: Tables not well developed, with small rounded disks, smooth but uneven on the margin, and with rather reduced spire, consisting of four upright pieces, one crossbeam, and a crown ending in four simple teeth or irregular. Frequently the upright pieces are not connected by transverse beams at summit. The small rods are irregular, deeply incised, warted or undulating along the margin; very numerous. Color in alcohol, very pale dull yellowish or grayish brown. The back is marked by about

six transverse irregular broad bands of dark olive brown, the intervals between being often much spotted with the same color, but sometimes much lighter. The whole integument is also finely dotted with olive greenish to brownish. In most specimens the bands on the back are decidedly greenish and the tubercles are marked by a yellowish-green base and a dark brown summit. Ventral surface finely dotted with olive, each pedicel being surrounded by an unmarked area at the base. Length about 100 mm.

Localities.—Honolulu, reef (9); Puako Bay, Hawaii (1); Laysan, reef (2).

The dorsal and ventral surfaces are well differentiated in this form. Just above the edge of the ventral area is a row of fifteen to twenty low tubercles, in some specimens hardly visible, in others easily seen by reason of their darker tips. The two dorsal series are very irregular in some examples, so that in the anterior half of the body no especial order seems to be present. The arrangement of pedicels in longitudinal bands is best made out in specimens which have been so hardened that the ventral surface is unwrinkled. The more numerous dots along the spaces between the bands make the latter all the more noticeable. In some examples, however, I find it impossible to distinguish any regular arrangement.

Calcareous ring of the usual form. Polian vesicle single, about 25 to 30 mm. long. Madreporic canal free, single, on right side of mesentery. Cuvierian organs present, forming a relatively very large bunch.

In this species both tables and buttons (if the peculiar rods may be so classed) are rather incomplete, although numerous so far as individuals are concerned. The disk is usually a subcircular but more or less irregular simple ring, with a fair-sized perforation at the base of each slender spire rod, and frequently supplementary holes between. The edge is usually smooth. Disks vary from 0.03 to 0.05 mm. in diameter; 0.038 to 0.046 mm. is the average. Spire has one cross beam, is frequently incomplete, and ends in four simple teeth. The crown may have no transverse pieces, in which case the spire is rather rudimentary, or there may be two or three of the teeth connected by transverse pieces (see figures). The rods commonly vary from 0.021 to about 0.072 mm. in length, although much larger rods, intermediate in size between the small ones and supporting rods, are present. These rods—or, as Lampert classes them, buttons—are very irregular. They are smooth and some of the commoner shapes are best seen from the figures. These forms are only a few among a great many variations. The pedicels possess well-developed terminal plates, but in the papillæ they are very rudimentary. The pedicels and papillæ, in addition to rather long, curved rods with short irregular processes scattered along the sides, have bilateral fenestrated plates,

and forms intermediate between the rods and plates are abundant. The simple rods are commonly about 0.3 to 0.35 mm. long. The processes along the sides may become more numerous and partially or wholly join, forming a series of irregular perforations. Rods of this sort are found intergrading with the small rods (see fig. 2*c*). The fenestrated plates, which are in the neighborhood of the terminal plate of the pedicels, are formed simply by the branching and joining of the lateral processes of the supporting rods. Théel does not mention these plates, but the other deposits agree so well with his description that I believe I have not erred in calling this form *pervicax*. The small rods are certainly very characteristic.

This is another widely distributed form. Théel summarizes the distribution as follows: Tahiti, Pelew Islands, Philippine Islands, Hawaiian Islands, Samoan Islands, Zanzibar, Mauritius, Red Sea, Australia. Bedford[a] considers this form a variety of *fuscocinerea*, which he believes includes also *curiosa* and *depressa*. His specimens were taken at Rotuma.

HOLOTHURIA ATRA Jäger.

Plate LXX, figs. 2, 2*a–c*.

Holothuria atra Jäger, De Holothuriis, 1833, p. 22.

Body elongate, subcylindrical, capable of considerable extension, tapering to a blunt posterior extremity. Mouth rather small, ventrally directed, surrounded by a not very conspicuous papillose collar. Anus terminal. Tentacles of medium size, twenty in number, the well-developed peltate crowns forming a double row. Pedicels of ventral surface numerous and crowded. Papillæ of dorsal surface rather prominent in life, slightly thicker than the pedicels and less numerous, being more widely spaced. In alcoholic specimens they are often quite inconspicuous on account of contraction. Perisome rather thick, tough, and of a leathery consistency. Deposits: Tables with a small annular disk, usually forming a simple ring with a perforation at the base of each vertical spire support; spire terminating in eight horizontal and four vertical, rather long teeth; a single crossbeam to spire, situated slightly nearer disk than summit. In addition to tables are small, usually incomplete, fenestrated plates, often in the form of X-shaped bodies with the arms dichotomously branched. The incomplete plates appear rather more numerous than the fully developed ones. Color, a very dark brown, almost black. Peristome and disks of pedicels, yellowish. Length of a large preserved specimen, 210 mm.; thickness, about 55 mm. In life this specimen would be capable of expanding to at least 300 mm.

[a] Proc. Zool. Soc., 1898, p. 837.

Localities.—Puako Bay, Hawaii (17), tide pools in lava rock; Napili, Maui (2); Honolulu Reef (1); Waialua, Oahu (1); Kamalino Bay, Niihau (1); Laysan Island, reef (1). Specimens examined, 23.

The very dark color will serve as a distinguishing feature for this species, the only other forms approaching it in shade being *H. cinerascens* and *vagabunda*. *H. fuscorubra* is lighter and reddish. Along the middle of the ventral surface I find in most specimens a narrow band free from pedicels. The papillæ vary greatly in the degree of contraction, so that it is impossible to gain a correct idea of their size from a preserved individual. The crowns of the tentacles appear to be black to dark brown, but the peduncle is lighter, translucent brownish.

The radial pieces of the calcareous ring extend farther forward than the interradial, and are of the usual type. The anterior edge has an abrupt, rounded incision, while the interradial pieces have an anterior tooth. The posterior edge of each piece is emarginated. Polian vesicles two in one specimen examined. In another there are seven, six of which are quite small. The madreporic canals form a tuft on each side of the dorsal mesentery, there being in one individual examined eight canals to each bunch. The right respiratory tree extends forward to the calcareous ring, and is firmly anchored to the body wall; the left is in connection with the extensive rete mirabile of the intestine. No Cuvierian organs are present in several specimens dissected.

The tables are numerous, but not crowded, and each possesses a small annular disk and a robust spire composed of four rods and one cross-beam. The latter is rather nearer the disk than the crown. The spire is surmounted by eight robust horizontal and four equally large vertical teeth, three at each corner of the subquadrate crown. The central hole of the crown is subcircular. Occasionally an extra tooth is present. The disks are about 0.055 mm. in diameter and most commonly consist of a simple ring with a perforation at the base of each spire rod. The spires are from 0.06 to 0.085 mm. high, and the crowns about 0.06 mm. broad, over all. The plates are small and irregular, varying in diameter from 0.019 to 0.045 mm. They are thus smaller than the plates figured by Clark,[a] presumably from Atlantic specimens. The tables of the Hawaiian examples, on the other hand, are larger, judging from the relative magnifications of my figures and Clark's. The disks of the tables, however, average relatively smaller to the proportions of the spire. The pedicels have a well developed terminal plate, and the papillæ a small one. Supporting rods are not abundant in the papillæ. They are usually curved, smooth (sometimes spinous) with the slightly dilated ends fenestrated.

[a] American Naturalist, XXXV, p. 493, fig. 26.

Close to the terminal plate of the pedicels a few fenestrated plates about 0.1 mm. in diameter are present. These are not infrequently bilateral.

This is one of the commonest holothurians inhabiting Hawaiian shores. It is rather common about the islands of Hawaii, on the leeward side at least, where it inhabits pools in the lava rock, in company with *Actinopyga mauritiana* and *Holothuria cinerascens*. In this region it does not appear to range out of the shore tide pools. The species is a very wide-ranging one, being found, according to Théel's and Lampert's summaries, in the following localities: Red Sea, Zanzibar, Madagascar, Djedda, and Indian Ocean, Querimba, Celebes, Java, Ualan, Radack Islands, Australia (Barrier Reef), Hawaiian Islands, Society Islands, Philippine Islands, Samoan Islands, Fiji Islands, Nicobar Islands, Amboina, Batchian, Molucca Islands, Macassar, Timor, Pedang, Pulo Tibul, Darros, Tahiti, Jamaica, Havana, Florida, Puerto Cabello.

* HOLOTHURIA MONACARIA (Lesson).

Psolus monacarius LESSON, Centurie Zoologique, 1830, p. 225, pl. LXXVIII.

Tentacles, 20; ventral surface with three longitudinal rows of pedicels; dorsal surface with four series of papillæ. Mouth surrounded by about twenty, often inconspicuous, papillæ. Deposits: Tables and buttons. Tables with rounded smooth disk, having a central hole surrounded by four to twelve peripheral holes; spire, consisting of four upright rods and one cross beam, terminates in twelve teeth or more. Oval smooth symmeterical buttons with three or four pairs of holes, mostly with three. Polian vesicle single; one small madreporic canal in dorsal mesentery. Brownish with ventral surface, the papillæ, and a space around them lighter; or dirty yellowish white, speckled with brown or greenish brown on back.

Théel[a] remarks that "in a small specimen from Mauritius, which is probably young, the pedicels are placed in three double or alternating rows on the ventral surface, an arrangement which is not so distinct in the remaining forms. Even the small dorsal papillæ do not always seem to be placed in very distinct rows. * * * The disks of the tables are slightly undulated on margin. The symmetrical or slightly asymmetrical buttons have often more than six holes, though this number is most common. The papillæ have a very rudimentary terminal plate, and curved, rod-like perforated deposits. Besides, both pedicels and papillæ contain numerous crowded buttons and tables, and near the ends bilateral perforated plates."

Not secured by *Albatross* expedition. This species has a wide range, extending from Zanzibar through the East India region to the Philippine Islands, east to Hawaii, and through the South Sea Islands to Australia. For a list of localities see Théel and Lampert.

[a] Challenger Holothurioidea, Pt. 2, p. 217.

*HOLOTHURIA VAGABUNDA Selenka.

Holothuria vagabunda SELENKA, Beiträge zur Anatomie u. Systematik der Holothurien, Zeitschaft. f. wiss. Zool., XVII, 1867, p. 334, pl. XIX, figs. 75–76.

Tentacles, 20. Ambulacral appendages, generally distributed pedicels. Deposits: Tables, and buttons. Tables with a not very large disk, and with the spire terminating in eight to ten teeth, placed around the nearly circular aperture in its top. Buttons of the usual form, with six holes. The dorsal pedicels alone have supporting rods, which are spinous and tapered toward the ends. Polian vesicles one to two; one free madreporic canal. Cuvierian organs brownish red to violet, very inconstant in number. Color, dark brown to light reddish brown, ventral surface whitish. Length about 200 mm.

Théel[a] states that in a number of specimens examined by him the ambulacral appendages appeared to be of nearly equal size on dorsal and ventral surfaces; but he always found the ventral ones cylindrical, and the dorsal ones more papilliform. "The ventral have a well developed terminal plate and bilaterally symmetrical, perforated supporting plates; the dorsal have a rudimentary terminal plate, and the ventral appendages are always more numerous than the dorsal. * * * The disks of the tables are sometimes not very well developed, sometimes round or angular with a large central hole and several peripheral ones, and their margin is often uneven."

Not taken by the *Albatross* expedition. Widely distributed, ranging from Panama and the west coast of South America and Hawaiian Islands through the South Sea Islands to east coast of South Africa, thence to Red Sea, East Indies, Philippines, and China (Hongkong).

*HOLOTHURIA HUMILIS Selenka.

Holothuria humilis SELENKA, Beiträge zur Anatomie u. Systematik der Holothurien, Zeitschr. f. Wiss. Zool., XVII, 1867, p. 339, pl. XIX, fig. 89.

Tentacles, 20; uniformly distributed pedicels. Deposits: Tables, and buttons. Tables with not very large disks and with spire terminating in eight teeth, similar to those of *vagabunda*. Buttons very flat, of usual shape. All pedicels with supporting rods, but ventral alone possessing terminal plates. Calcareous ring very small and of uncommon shape, its ten pieces being very small, round, and brown. Several Polian vesicles; free small madreporic canal. Grayish brown. Length, 130 mm.

"Distinguishable from *vagabunda* mainly by the peculiar calcareous ring, which is unlike that of any other holothurian." (Théel.)

Not secured by the *Albatross* expedition. The Hawaiian Islands constitute the only recorded locality.

[a] Challenger Holothurioidea, Pt. 2, p. 219.

HOLOTHURIA FUSCO-RUBRA Théel.

Plate LXVIII, figs. 3, 3*a–c*

Holothuria fusco-rubra Théel, Challenger Holothurioidea, Pt. 2, 1886, p. 182, pl. VII, fig. 2.

General form robust, subcylindrical. Mouth terminal, directed somewhat ventrally, surrounded by a slight collar. Anus terminal. Tentacles 20, rather long. Dorsal and ventral surfaces well differentiated, the former with rather well-spaced papillæ, the latter with crowded pedicels. In one specimen an indistinct indication of serial arrangement is present near the hinder end of the body. Body wall thinner than usual in the genus. Deposits: Incomplete tables with a spinous rimmed disk and rudimentary spire; occasionally the latter is entirely absent; buttons as a rule incomplete; when complete usually asymmetrical with six or seven holes. Larger buttons are present near the tips of pedicels. Well-developed Cuvierian organs. Color in alcohol purplish brown to a distinct dull magenta in a young example. Length, about 110 mm.; tentacles 10 mm. long.

Localities.—Laysan Island, reef (6 specimens); Necker Island (1 specimen); Hanalei, Kauai (1?, no calcareous deposits).

Most of the specimens are in a bad state of contraction, so that it is not possible to give many details of the external appearance. The papillæ appear to be slightly larger than the pedicels. Those near the tentacles are considerably larger than the rest. The integument is decidedly smooth to the touch, doubtless due to the absence of spires to tables or their feeble development.

The calcareous ring is of the usual form. Polian vessicle single in the specimen dissected. One madreporic canal is present on the right side of the mesentery.

The disks of the tables vary in diameter from about 0.045 to 0.06 mm., 0.05 to 0.055 mm. being the common dimension. The border is uneven and usually spiny. In the smallest tables the disk consists of a simple ring with four spokes meeting at the center. Then two of the crosspieces may have a perforation at the base. There is every gradation from this form to that in which there are numerous perforations about the edge. The simpler disks usually lack the spire, which is almost never complete, even when present. The spire varies from a tiny knob on each crosspiece of the disk to four low rods which are incompletely joined at the summit by transverse pieces. Rarely the crown is complete, when it presents the form of a simple ring with about eight irregular teeth on the border. The latter have no constant occurrence. The principal kinds of tables are figured. The buttons are very incomplete and vary so much that it is difficult to find two alike. They are numerous and are about 0.06 to 0.07 mm. long. In the ambulacral appendages larger buttons with eight or more holes are

present (0.095 mm.). Complete regular buttons have six holes in two rows. Some specimens have more complete buttons than others. The figures will show a few of the principal variations, although, as already mentioned, it is difficult to duplicate any of the irregular patterns. The pedicels have a well developed terminal plate. Near this plate are numerous irregular, but more or less bilateral, fenestrated plates, about 0.08 by 0.18 mm. The dorsal papillæ have the rudiments of a terminal plate and the walls are strengthened by numerous slightly curved rods with short branches along the sides, often uniting to form one or two holes. The tips are slightly expanded and have one or two perforations, or none. Frequently the lateral branches are very short and appear as spines. An average rod is about 0.35 mm. long, although much shorter and slightly longer forms occur. Grotesque incomplete buttons (or plates) of the large variety are present, with fewer complete examples.

According to Théel, this species is most nearly related to *Holothuria curiosa* Ludwig. There appear to be more tables and spires in the *Albatross* material than in the type specimen of Théel, which came from the "Sandwich Islands." Considering, however, the form of the buttons and color of the animals there is little doubt but that my specimens are referable to Théel's species. Clark [a] has recorded this form from Albemarle Island, Galapagos group, and Sluiter from Paternoster Island (Siboga Holothurioidea, p. 15).

HOLOTHURIA ARENICOLA Semper.

Sporadipus (*Acolpos*) *maculatus* Brandt, Prodr., 1835, p. 46.—Lampert, Seewalzen, 1885, p. 73.

Holothuria arenicola Semper, Holothurien, 1867, p. 81, pl. xx; pl. xxx, fig. 13; pl. xxxv, fig. 4.—Théel, Challenger Holothurioidea, Pt. 2, 1886, p. 222.

General form subcylindrical, elongate, blunt at both ends; body rather slender, the ventral surface arched, but not so much so as the dorsal. Mouth small, turned ventrally, the circlet of very small tentacles surrounded by an inconspicuous collar bearing blunt papillæ. Anus terminal, bordered by five angular groups of three to six short papillæ. Tentacles very much retracted, apparently about twenty (which is the normal number for this species). Ambulacral appendages in the form of pedicels more or less scattered. The two ventral ambulacra are well marked, the pedicels being larger and rather closer together than on dorsal surface. A faint indication of arrangement in series is seen. Body wall of medium thickness. Deposits: Buttons and tables; the former rather regular, smooth, with six holes and with the edge regularly indented between each pair of holes; the latter with an annular disk with a very large central hole and a small hole at base of each spire support; exceptionally with more holes;

[a] Proc. Wash. Acad. Sci., IV, 1902, p. 527.

spire made up of four rods, one crossbeam, and a crown ending in twenty to thirty teeth. Supporting rods of pedicels smooth, dilated at the ends and in the middle, where there are several perforations. Color of a well preserved specimen: ground color a grayish white, with a faint suggestion of green, dotted minutely with fine brownish specks. Along the back are two rows of brown spots, fifteen to a row. The fine dots are inconspicuous and less numerous on the ventral than on dorsal surface. Length 145 mm., breadth at middle of body 22 mm.

Locality.—Honolulu, reef, 2 specimens.

Near the extremities of the body on the ventral surface one can distinguish an irregular arrangement of pedicels in four rows. Near the middle this is not so obvious. The two ventral ambulacra are well marked, however, a line and a narrow area free from pedicels passing along the middle of the abdomen. I have not examined a specimen of *monacaria* which has the ventral pedicels in three rows, so do not know how much more obvious the arrangement may be in that species. A second and smaller specimen of *arenicola* has the general tint of the body light brownish and the dark purplish-brown dots much more conspicuous than in the first example. The large spots on the back are rather broken up, consisting of accumulations of smaller spots.

The calcareous ring is rather small. The radial pieces are a trifle longer than broad, truncate anteriorly, with the usual obtuse incision, which is small. Interradial pieces very much smaller than the radial, although about of the same width. They have one anterior tooth, while the posterior border is rather conspicuously excavated; that of the radialia less so; one Polian vesicle; one madreporic canal, free, on the right side of the dorsal mesentery. This agrees with Lampert's diagnosis. Théel mentions two Polian vesicles and a bunch of three small madreporic canals in a Samoan specimen. One of the specimens examined has no Cuvierian organs.

The oval, smooth buttons are very numerous. They vary slightly in length, 0.065 to 0.068 mm. being the average. The width is also variable, 0.027 to 0.0325 mm. being commonest. Although six regular holes are the rule, eight also occur. The disk of the tables has a smooth border and is quadrate-circular in outline. The commonest form is figured (Plate LXVIII, fig. 5). Occasionally there are more peripheral holes, but the regular form is remarkably constant. Viewing the disk from the bottom, the large central hole might be interpreted as four holes, on account of the spire rods. Viewed from the side the tables resemble those of *H. impatiens* with one crossbeam. The disk, however, is altogether different. The spire is about 0.046 mm. high, while the diameter of the disk varies from 0.051 mm. to about 0.065 mm. The number of teeth crowning the spire is variable, but always more than twenty. The supporting rods of the pedicles are smooth, often more simply or more elaborately perforated than

shown in the figure, which represents the average. Their length is about 0.15 to 0.2 mm. The terminal plates of the ventral pedicels are larger (0.37 mm. in diameter) than those of the dorsal pedicels (0.24 mm. in diameter).

This species, which is now, I believe, for the first time recorded from the Hawaiian Islands, ranges from the Red Sea and Indian Ocean to the west coast of tropical America, and in the Atlantic is found on the north and east coasts of South America. The following are the principal stations recorded: Kosseir (Red Sea), Mauritius, Zanzibar, Philippines, Bonin, and Marshall islands, Amboina, Rotti, Sula Besi, Fiji and Samoan islands, Cocos Island off Central America, Galapagos Archipelago, Surinam, and Bahia. The name *Holothuria maculata* (Brandt) is technically invalidated by *Holothuria maculata* Chamisso and Eysenhardt, 1821.

HOLOTHURIA PARDALIS Selenka.

Plate LXIX, figs. 1, 1*a–g*.

Holothuria pardalis Selenka, Beiträge zur Anatomie u. Systematik der Holothurien, Zeitschr. f. wiss. Zool., XVII, 1867, p. 336, pl. xix, fig. 85.

Apparently quite a variable species. Possibly the forms here considered should be classed under two species, *H. pardalis* and *H. lineata;* but without authentic specimens for comparison it is impossible to decide. The various characters grade into one another in such a way that it would seem best to consider the Hawaiian specimens as belonging to *pardalis*. Two of the specimens are quite typical *pardalis* according to descriptions.

Size medium to small; general form subcylindrical, tapering toward either end; mouth and anus terminal; the former surrounded by seventeen to twenty small tentacles, the latter by a crown of papillæ. Ambulacral appendages in the form of pedicels more or less obviously arranged in five longitudinal bands, especially at extremities of body. In half the specimens, however, this regular arrangement is not apparent or at least not obvious enough to be of importance. Ventral surface not clearly defined from dorsal in most specimens; the ventral pedicels with larger disks than the dorsal. Body wall not particularly thick, the exterior fairly smooth. Color variable; thus, a specimen, typical as far as deposits are concerned, was colored in life as follows: Tentacles light yellow; dorsal surface brownish straw color, lighter straw color about pedicels; ventral surface without the mottled appearance, lighter; along the dorsal surface are two rows of dark brown spots, twelve to fifteen in each row. Another specimen is a rather darker brownish, lighter about pedicels; no dorsal spots. Still another has small dark brown spots scattered all over the body irregularly, yellow about pedicels, the two rows of dorsal blotches being rather inconspicuous. Deposits: Tables with a spinous disk, usually somewhat

irregular in contour, and with the low spire ending in about eight teeth, commonly fewer. Buttons both regular and irregular, the latter most numerous, the former of the usual shape with six to eight holes. All buttons are accumulated into rings or circles, or sometimes only in groups. Supporting rods of pedicels, smooth, slightly curved, expanded and perforated at tips. Length, 80 mm.

Localities.—Honolulu, reef, under rocks at low tide (11); Puako Bay, Hawaii (2).

The variations in color and in the arrangement of pedicels have already been touched upon in the diagnosis above. The tentacles are very small, apparently smaller in some specimens than in others, but this is difficult to ascertain with any degree of exactness. The number is certainly variable, seventeen being the smallest number, and this in a specimen otherwise quite typical.

Calcareous ring comparatively small and delicate, the pieces being rather loosely joined. Interradial pieces rather wider than radial, or at least as wide, but of the usual shape. Each radial piece is prolonged slightly farther forward than the interradial and has the usual roundish incision. The anterior edge of the interradialia has a single tooth. Polian vesicles two, rather long. Madreporic canal small, single, free, on right side of mesentery. No Cuvierian organs. Respiratory tree with left branch in communication with rete mirabile of intestine. The gonad in one specimen is large and the strands have a moniliform appearance.

The most characteristic feature of the deposits is the accumulation of the buttons in small circles or circular groups, which may be seen with a hand lens in an ordinary alcoholic specimen. Here they appear as small whitish spots. The diameter of such a circle or group varies from 0.13 to 0.3 mm. The buttons are very frequently incomplete; usually more or less irregular even if complete, when they are of the usual form, with from five to eight holes in two rows. When the buttons are fairly regular, with six holes, the median pair is the larger. Rarely a button has two or three irregular, illy defined prominences on the surface. An average button measures 0.065 mm. in length; many are smaller than this, being only 0.045 mm.; some are as long as 0.08 mm. and appear to be confined to the ambulacral appendages. The irregularity of some buttons is enhanced by a slight twisting on the long axis. Some specimens appear to have a greater proportion of complete buttons than others, while in some individuals the proportion of regular buttons is greater. The form of the tables is better shown by figure than description. The disk is rather variable as to size, ranging from 0.054 to 0.085 mm. in diameter. The edge appears always to be spiny. As a rule the disk is rather stout and either has four perforations, one at the base of each spire support, or eight when the disk is larger and more nearly circular.

Small disks with no peripheral holes and with the spire reduced (1*d*) are not uncommon. All these are found in the same specimen. One or two specimens have the small disks (*d*) and slight variations of of "1*a*" preponderating, few of "1" type being present. In these specimens the spines of the disk are much more prominent and the spire is frequently rudimentary or incomplete. There are many buttons scattered between the circles. Still another specimen has tables of the "1*a*" type in greatest abundance, "1*d*" much less numerous. There is, however, so much variation in the shape of the tables of a single specimen that nothing can be made of slight differences in the deposits of different specimens. The supporting rods are very characteristic, their form being best appreciated by the figures. They vary from about 0.18 to 0.32 mm. in length. The dorsal pedicels have smaller terminal plates than the ventral.

* HOLOTHURIA INHABILIS Selenka.

Holothuria inhabilis SELENKA, Beiträge zur Anatomie u. Systematik der Holothurien, Zeitschr. f. wiss. Zool., XVII, 1867, p. 333, pl. XIX, figs. 73–74.

Tentacles 20. Pedicels numerous, uniformly distributed. Deposits: Tables and buttons. Solid tables with twelve spines on margin of disk. The very numerous buttons are of a more unusual shape, symmetrical swollen, with two rows of minute holes, about four holes in each row; the surfaces of the buttons are uneven, owing to the presence of flattened elevations (no knobs), and their margin is deeply undulated. Madreporic body free, very small. In the middle line of ventral surface is a deep longitudinal furrow. Skin thick and rough. Blackish brown. Length 80 mm.

Not secured by *Albatross* expedition. Recorded also from Society Islands.

HOLOTHURIA IMPATIENS (Forskål).

Plate LXIX, figs. 4, 4*a–d*.

Fistularia impatiens FORSKÅL, Descriptiones animalium, etc., 1775, p. 121, pl. XXXIX, fig. B.

Holothuria impatiens GMELIN, Linnæi Systema Naturæ, 13th ed., 1788, p. 3142.

Body elongate; general form subcylindrical, broadest in posterior region. No superficial distinction between dorsal and ventral surfaces. Mouth and anus terminal, the former rather small. Tentacles, 18 to 20, crowded. Ambulacral appendages pedicel-like "papillæ," borne on warty protuberances, which are frequently conspicuously lighter in color than the rest of body. They are fairly evenly scattered over the surface, and do not form series. They have a terminal plate. Perisome wrinkled, and roughened by the spires of the tables, so that the texture is very characteristic. Deposits: Crowded tables and buttons; tables with a subcircular smooth disk pierced by a central and eight peripheral, slightly smaller holes; spire consisting of

four upright pieces and two transverse beams (more rarely one) and the rounded summit provided with numerous teeth. The rather symmetrical, smooth buttons with six holes. Supporting rods are present in the papillæ. Color in alcohol reddish brown; the protuberances being usually lighter. In one specimen they are light yellow, sharply defined against the purplish brown surface. Length, 100 mm.; thickness in widest part, 24 mm.

Localities.—Honolulu Reef (2 specimens), Necker Island (7), Laysan Island (2), Station 3834, south coast of Molokai Island, 8 fathoms (1).

Naturally enough the preserved specimens vary considerably in shape, because of the different degress of contraction. As a rule, however, the body is thicker toward the posterior end, and resembles a minature "summer squash" in general form. The circlet of tentacles is rather narrow. The protuberances of the body are conspicuous, and in some specimens there is an indication of their being confined, beyond the middle of the body, to the ambulacra. The so-called papillæ really resemble pedicels, as there is a terminal sucking disk and plate. Théel on page 181 of the second memoir calls them pedicels, and on page 233 papillæ. They are always found on protuberances however. Judging from alcoholic specimens the color is variable, especially as regards the relative shades of the general surface and the papillæ warts. In some individuals they are not noticeably lighter than the light purplish brown interspace. The ventral surface is a trifle lighter than the dorsal, but otherwise superficially very similar.

The radial pieces of the calcareous ring are much larger than the interradial and project much farther forward. The rounded margin has a deep obtuse incision. The interradial pieces have one short tooth. Madreporic canal single, on right side of mesentery, free for its whole length in body cavity. Polian vesicles two to four. Cuvierian organs in a relatively very large bunch. Longitudinal muscle-bands very thick.

The tables are so crowded that the edges of the disks touch or overlap slightly, and beneath these the buttons form an evenly distributed, crowded layer. The disks of the tables average between 0.08 and 0.95 mm. in diameter, and the robust spire is 0.09 mm. high and about 0.05 mm. in diameter, consists of four upright rods, two crossbeams, and the summit is surmounted by many teeth. A number of the teeth are on a level with the upper crossbeam. The disk is not exactly circular, but tends toward the subquadrate, and is typically pierced by nine holes, forming three rows, the central hole being a trifle larger than the rest. Occasionally as many as six or seven very small perforations are scattered around the margin, between it and the primary holes. The buttons average about 0.09 mm. in length. They are smooth, have slightly undulating margins and obtuse ends. There are

almost invariably six holes. Slightly curved supporting rods, dilated at the middle and perforated at the ends and in the middle, are present in the papillæ. Often the rods have two or three short branches in the middle, or the branches may meet, enclosing a hole. Frequently the tips are not perforated.

*HOLOTHURIA VERRUCOSA Selenka.

Holothuria verrucosa SELENKA, Beitrage zur Anatomie u. Systematik der Holothurien, Zeitschr. f. wiss. Zool., XVII, 1867, p. 338, pl. XIX, fig. 19.

Tentacles 20. Papillæ uniformly distributed. Deposits: Tables and buttons. Tables very solid, the disk with spiny rim. Spire with four upright rods and one crossbeam. Buttons smooth with scalloped margin. Papillæ with numerous spinous or perforated plate-like rods. Polian vesicles, two; one bunch of small madreporic bodies; tentacle ampullæ large. Skin rough. Black, the papillæ bright brown. Length, 180 mm. Lampert found the calcareous ring to be very small.

Not taken by *Albatross* expedition. Recorded also from Zanzibar and Indian Ocean. Sluiter records a specimen from Rotti.[a]

HOLOTHURIA HAWAIIENSIS, new species.

Plate LXVIII, figs. 4, 4*a–g*.

Size small; general form subcylindrical but flattened ventrally, well arched dorsally. Mouth directed somewhat ventrally; anus terminal. Tentacles 30, crowded, not very large. No evident circumtentacular collar. Ventral surface with not numerous, rather large pedicels more or less evidently arranged in three series. Dorsal surface with scattered papillæ, less numerous than the pedicels but of about the same size. Body wall rather thin, minutely roughened. Deposits: Tables and rather irregular buttons, with well developed and numerous supporting rods in the ambulacral appendages. Tables of two or three kinds: (1) Disk with a smooth undulating or irregular margin, with a large central hole and with eight to ten slightly smaller peripheral ones; spire made up of four rods and two or three crossbeams, the crown ending in twelve to sixteen teeth, sometimes irregular, with less. (2) Much smaller tables with usually an annular disk with a large central hole, and one at base of each spire support; sometimes with more; spire with only one crossbeam, the crown either truncate or pointed, irregular, ending in numerous teeth. Buttons accumulated in small rings or circles, or circular groups, and in larger rings about the base of ambulacral appendages; more or less irregular or sometimes slightly twisted, or one-sided, frequently fairly regular; holes vary from four to sixteen, average eight to fourteen; incomplete buttons are common. Color, ground tint light olive brown more or

[a] Siboga Holothurioidea, p. 13.

less marbled on back with raw sienna (yellowish); dark brown about base of papillæ, tip of latter light. Whole body closely dotted with white (the groups of buttons). A specimen from Necker (?) has the ground color Vandyke brown and the marbling is in the form of light yellowish-brown areas about the papillæ. Some papillæ of the type have a light circle about the base instead of one of brown. Length, 45 mm.; width, about 12 mm.

Localities.—Type (Cat. No. 21212, U.S.N.M.) from Station 3876, Auau Channel, between Maui and Lanai Islands, 28 to 43 fathoms; sand, gravel (6 specimens); 3872, same locality, 43 to 32 fathoms, yellow sand, pebbles, coral (2 specimens); Necker Island (probably), (2 specimens).

The tentacles in the dredged specimens seem quite constantly 30 in number, but in a specimen from Necker there appear to be only 25. Inasmuch as they are very retracted, it is entirely possible some have escaped notice or been lost. The form of the tentacle possesses nothing unusual. The pedicels are not always obviously arranged in three rows unless fully expanded. When fully expanded, the dorsal papillæ are pointed, the terminal plate being very rudimentary.

The radial pieces of the calcareous ring are more than twice as large as the interradial, but both elements are of the usual shape. Polian vesicle single, large. Madreporic canal single, free, on right side of mesentery. The gonad is well developed, showing that the specimens are adult. It consists of a thick tuft of simple strands, which are long. Cuvierian organs well developed, forming a tuft at the junction of the two branches of the respiratory tree. Left respiratory tree in connection with the retemirabile of the intestine.

The tables with a tall spire are numerous. There are also many intermediates, between forms *c* and *d* (fig. 4, Plate LXVIII), individuals with two crossbeams to the spire being more common than those with three. The disks of the large tables vary in size, as may be seen by comparing *b* and *d*, 0.073 and 0.063 mm. in diameter, respectively. The tall spires commonly terminate in a small crown of as many as sixteen teeth, frequently less regular than *b*. The small tables either have a pyramidal form (*e*) or are more truncate (*f*). In either case the disk hardly ever reaches 0.06 mm. in diameter, 0.055 being the average. The pyramidal form is commonest, and the crown has eight to twelve short teeth irregularly placed. Occasionally the rim of the tables has a few very short teeth on the margin. This form occurs in the same individual on which the smooth rims are prevalent. On the whole the tables are rather variable, but the average is summed up in the diagnosis. The most characteristic feature of the buttons is their accumulation in circular groups, or fairly large rings surrounding the base of pedicels and papillæ, recalling *H. pardalis*. The buttons vary greatly in size, the ordinary extremes of length being 0.034 to about 0.12 mm., the number of holes ranging from four to sixteen, or

even more. Generally speaking, the large buttons are found about the base of the pedicels and papillæ, being usually the innermost of the group, while the small ones are found in the small intermediate groups and around the outer edge of the ambulacral rings. The majority of the buttons are of the smaller sizes, and are frequently very irregular or even incomplete, the majority having about eight perforations. In a specimen from Necker the buttons average a trifle more regular than in the Auau Channel examples, and have about eight holes, but here, too, there are a great many incomplete, contorted, and generally irregular forms. A rather prevalent variation is shown in 4*f*', where a loop is formed over the central shaft of the button, and odd processes grow out toward the center from the edge. The supporting rods of the pedicels and papillæ are numerous, curved, expanded slightly at the tips and in the middle, where there are one or two perforations on either side. The expanded tips are often perforated and the edge of the rods is thorny. Forms intermediate with the large buttons are sometimes present. They have a number of perforations along either side of the central shaft. In the papillæ the rods frequently are more elaborate and have branches at the middle which may or may not unite. When they do, a fenestrated plate, which, however, retains its rod-like character, is formed. In the papillæ also are many of the large tables. The end plate of the papillæ is very much reduced, but that of the pedicels is as usual well developed.

This species is characterized especially by having 30 tentacles, dorsal papillæ and ventral pedicels, two or three kinds of tables, one of which has two or three crossbeams, irregular buttons disposed in circular groups and rings. The number of tentacles and general character of the deposits, as well as the ambulacral appendages, ally this form to *H. discrepans* Semper, *H. immobilis* Semper, and *H. samoana* Ludwig. From *discrepans*, *hawaiiensis* differs in having two distinct kinds of tables, neither of which greatly resemble the figures given by Semper;[a] in having the buttons not only about the ambulacral appendages, but likewise in numerous intermediate groups, and in having the buttons very variable in size and frequently irregular and large; in having differently shaped supporting rods; and, finally, in color. The calcareous ring is very characteristic and may furnish an additional difference. Neither *immobilis* nor *samoana* are any more nearly related to *hawaiiansis* than is *discrepans*.

[a] Holothurien, 1868, pl. XL, fig. 7.

HOLOTHURIA ANULIFERA, new species.

Plate LXIX, figs. 2, 2*a–d*.

Size small; general form cylindrical, rather slender. Mouth and anus terminal. Tentacles 20, not large. Dorsal and ventral surfaces well differentiated, the former beset with slender papillæ, forming about six longitudinal, irregular series, the latter with more numerous pedicels in four single series. Body wall rather thin. Deposits: Tables, and small robust rods with knob-like processes, together with incomplete buttons bearing knobs, and very few complete buttons, the small knobby rods being by far the most numerous; these in small circular groups and rings. Tables with a simple annular disk, there being a perforation at the base of each spire support, with often a few additional small perforations; edge spinous. Spire low, as a rule, with four rods, one crossbeam, and the small crown ending in four to eight short, blunt teeth. Comparatively few of the tables have the spire much higher, ending in four teeth and the smooth disk reduced to a simple ring, often without any perforations. Simple and branched supporting rods in papillæ; fenestrated supporting plates in pedicels. Color in alcohol, dorsal surface yellow ocher, lighter about base of pedicels, splashed with small irregular spots of red; ventral surface grayish, more sparsely spotted with red. Length, 55 mm.; width, 8 mm.

Localities.—Type (Cat. No. 21213, U.S.N.M.) from Station 3872, Auau Channel, between Maui and Lanai islands, 43 to 32 fathoms, yellow sand, pebbles, coral; bottom temp., 74.6°; 2 specimens. Station 3876, same locality, 28 to 43 fathoms, sand and gravel; 1 specimen.

The calcareous ring is rather delicate, but the pieces are of the usual shape. The interradialia are much smaller than the radialia, and each are about equally excavated (in proportion to relative size) on the posterior margin. The anterior margin of radial pieces is deeply incised, while that of the interradial is in the form of a single tooth, as usual. Polian vesicle single. Madreporic canal one, on right side of mesentery, free. Gonad fairly well developed. Cuvierian organs present, apparently in a state of development.

The tables are rather delicate and small. When viewed directly from above or below, the spines of the margin are not so apparent as when the disk is seen from the side, because the teeth are directed upward. The disk has a cruciform central hole, and four peripheral ones at the base of each low spire support. Frequently one or two small accessory perforations are present near one or two of the peripheral holes. The diameter of the disk of this sort of table is about 0.04 to 0.048 mm. The spire commonly terminates in from four to eight teeth, eight when fully complete. Sometimes one or two sides

of the subquadrate crown lacks a crosspiece. Occasionally the crown is more circular. A much rarer form of table is shown in figure 2*b*, Plate LXIX. Here the disk is much reduced and the spire correspondingly elongated. This form is apparently confined to the walls of papillæ and to the center of the groups of rods, where there are commonly three or four. The rest of the calcareous deposits are in the form of small knobby rods or very incomplete buttons with knobs, the principal forms being shown in the figures. They vary in length from 0.02 to 0.038 or 0.04 mm. Rarely there is a complete button 0.05 mm. long. A characteristic feature of these deposits is their accumulation in small circular groups or in small rings. They also form large rings about the base of the ambulacral appendages. A relatively few are scattered between the groups, which are rather close together. The supporting rods of the papillæ are curved with a spinous margin; the tips being a trifle expanded, spinous, and commonly perforated. At the tip of the papillæ the rods become smaller, laterally branched, the branches sometimes joining to inclose meshes. Then the rods resemble very open plates. Very rudimentary terminal plates appear to be sometimes present. The papillæ are further strengthened by the peculiar long-spired, small-disked tables already mentioned. The pedicels (of the ventral surface) have very well developed terminal plates, and in the vicinity of these are numerous bilateral curved elliptical fenestrated supporting plates about 0.13 mm. long and with one or two tiers of holes on either side of the central shaft. The margin is often rough or toothed. The tables in the walls of the pedicels are of the ordinary shape with a smooth margin. None of the slender curved supporting rods found in the papillæ are present in the pedicels, except possibly on the transition area between pedicels and papillæ (lateral).

This species is especially characterized by the form of the tables, and the curiously knobbed, mostly incomplete buttons and rods, arranged in circular groups and rings. It is very perplexing and should probably be ranked in Théel's *Holothuria atra* group[a] along with *grisea*, *inornata*, and others. The deposits, especially the knobbed buttons and rods, are entirely different from those of *atra* or any nearly related form. *Anulifera* is also related to *pervicax*, perhaps more closely than to *atra*.

HOLOTHURIA FUSCO-OLIVACEA, new species.

Plate LXIX, figs. 3, 3*a–f*; Plate LXX, fig. 3.

General form stout; subcylindrical, blunt at both ends. Mouth directed ventrally; anus terminal. Dorsal surface well arched and covered with rather widely scattered papillae; ventral surface well

[a] Challenger Holothurioidea, Pt. 2, p. 213.

marked from dorsal and beset with more numerous pedicels without order; pedicels not crowded. Tentacles 18, with fairly large crowns. Circumoral collar slight or not at all present; impossible to tell from condition of specimen. Body wall very tough but not remarkably thick. Color in alcohol: Dorsal surface rather dark olive brown; papillæ surrounded by a lighter ring; ventral surface dull grayish brown or light sepia, tentacles yellowish. Deposits: Tables and rough buttons. Tables of two kinds: (1) Numerous small tables with a simple annular disk bearing blunt spines on the edge and with a cruciform central hole and a perforation formed by the forked base of each spire support; or the disks may be larger with a small perforation at either side of the larger peripheral ones; spire low, made up of four rods; one crossbeam, and a circular crown bearing about 8 teeth; crown often incomplete or irregular, sometimes quadrate; (2) a few very large tables with a large perforated disk, irregular margin, and a spire ending in a single (?) point. Buttons elliptical with two to twenty-two holes, usually four or five, the edge rough, and the surface covered with very many small granular elevations. Length about 65 mm.

Locality.—Station 3834, south coast of Molokai Island, reef near Kaunakakai.

Type.—Cat. No. 21214, U.S.N.M.

In addition to somewhat larger papillæ, comparatively few in number and each in the middle of a light spot, there are scattered between them more numerous smaller ones. The larger papillæ, easily seen by the light spots, form about five very irregular rows. There are also numerous small pedicels scattered among the larger ones. The anal aperture is without special groups of papillæ. Surrounding the tentacles there is a slight ridge with pedicels and papillæ, but it apparently did not form a collar before contraction.

The calcareous ring is moderately stout and of the usual form. The interradial pieces are considerably smaller than the radial. Both are excavated on the posterior margin. Anteriorly the interradials have a single tooth, the radials being deeply incised. Madreporic canal single, free, on the right side of the mesentery. Madreporic body elongate. Polian vesicle single. Gonad small. Cuvierian organs in a large tuft. Left branch of respiratory tree not intimately connected with intestinal vessels.

The disks of the smaller tables have a very characteristic form, as shown by fig. 3, Plate LXIX. The simplest forms have only the four peripheral holes, the larger disks possessing a small perforation on either side of one or more of these. The large central hole instead of being circular is always cruciform. The disks are usually between 0.056 mm. and 0.086 mm. in diameter. The spires are low, made up of four rods and one crossbeam, and a more or less circular crown (which is frequently incomplete), bearing normally eight teeth (hori-

zontal), but sometimes fewer, rarely more. The large tables are very scarce, and the tips of the few seen appeared to have been broken. The form is best shown by the figure. The disk is perforated with several tiers of holes and has no well-defined rim, being irregular from imperfectly inclosed perforations. The spire is about 0.12 mm. in height (relatively too small in drawing) and has two or three cross-beams. Apparently it ends in a single point. The buttons differ much in size. While a very few are smooth, the vast majority are irregularly beset with small protuberances, and the edge is minutely incised. Common forms are figured. The average length varies from about 0.05 to 0.09 mm., but buttons 0.135 mm. or even larger are present in the ambulacral appendages. An average button of the dorsal perisome measures 0.056 mm., but in buttons of this size the number of irregular holes varies from one to eight. Frequently asymmetry characterizes the number and position. The supporting rods of pedicels and papillæ are curved, robust, smooth, with a spiny or scalloped border. The middle is expanded and perforated on either side of the central shaft and the tips are slightly expanded also, commonly minutely perforated. In the pedicels the rods frequently have only lateral processes at the sides, with denticulate ends. These processes, by joining at the tips, form perforations. At base of pedicels and papillæ large rods or buttons of intermediate form are found, rather more sparsely knobbed than the regular buttons. They resemble the largest buttons rather more than rods. When the little protuberances begin to appear on the rods, it is at the edges. Pedicels have large terminal plates; the papillæ small rudimentary ones.

This species is apparently quite unique. At least there are no close relatives.

Genus LABIDODEMAS Selenka.

Labidodemas Selenka, Beiträge zur Anatomie u. Systematik der Holothurien, Zeitsch. f. wiss. Zool., XVII, 1867, p. 309. Type, *L. semperianum*.

Tentacles 20. Ambulacral appendages, pedicels and papillæ, the former in a double series along each of the three ventral radii, the latter in a double series along two dorsal radii, or pedicels alone. Interambulacra naked. Single genital bundle on left side of dorsal mesentery. C-shaped deposits. All deposits absent in one species. No anal teeth. The C-shaped deposits unlike those of Stichopus. Genus differs from *Holothuria* in arrangement of pedicels and papillæ.

*LABIDODEMAS SEMPERIANUM Selenka.

Labidodemas semperianum Selenka, Beiträge, p. 309, pl. xvii, figs. 1–3.

Tentacles 20, very small; pedicels in three ventral double series; papillæ in two dorsal double series. Deposits: Tables, buttons, and C-shaped bodies. Tables with a spire made up of five rods, one cross-

beam, and terminating in about ten teeth. Buttons smooth. Among the buttons many rods and C-shaped bodies. Radialia of calcareous ring much higher than interradialia. One Polian vesicle, one madreporic canal in dorsal mesentery; gonad branched. Color in alcohol (Sluiter) yellowish gray, darker brown at either end; pedicels and papillæ yellowish or bright reddish brown, ventral surface brighter than dorsal, and darker at anterior end.

This species was not secured by the *Albatross* expedition, which is to be regretted, since the type locality is the "Sandwich Islands." Sluiter[a] unites *semperianum*, *selenkianum*, and *dubiosum*. The deposits appear to be more or less variable. The same animal will possess tables with well-developed and small disks, the former having six or seven large holes. The so-called buttons are not typical, but rather to be considered perforated plates with several corners.

If these three forms represent a single species, it thus ranges from the Hawaiian Islands to Tahiti and Fiji Islands, and into the East Indies (Sluiter: Seba, Pulu-Passi-Tanette, Rotti, Timor, Salyer, Elat).

Genus STICHOPUS Brandt.

Stichopus BRANDT, Prodr. desc. animal. Mert., 1835, p. 50.

The following description is by Théel:

Tentacles, 18 to 20. Ambulacral appendages in the shape of pedicels and papillæ, the former arranged in three more or less distinct longitudinal series on the ventral surface, the latter mostly situated on the tops of larger or smaller protuberances, forming rows along the dorsal ambulacra or scattered all over the dorsal surface. Two bundles of genital tubes, one on each side of the dorsal mesentery. Anus devoid of calcareous teeth. C-shaped deposits often present in the perisome.

KEY TO HAWAIIAN SPECIES OF STICHOPUS.

a Dorsal ambulacral appendages present only on the ambulacra. No large tables, with the spire terminating in a single point ..... *chloronotus.*

aa Dorsal ambulacral appendages scattered on interambulacra as well as on ambulacra. Large tables in papillæ, with conical spire terminating in a single sharp point ..... *tropicalis.*[b]

*STICHOPUS CHLORONOTOS Brandt.

Stichopus (*Perideris*) *chloronotos* BRANDT, Prodr., 1835, p. 50.

Tentacles 20; mouth surrounded by a crown of papillæ. Dorsal ambulacral appendages, in the shape of conical warts or protuberances, distributed in a double alternating row along each side of the body, as well as along the dorsal ambulacra; their arrangement in a double row is more distinct in the dorsal ambulacra than on the sides. The odd interambulacrum and those of sides of body naked. Ventral pedicels crowded, the middle row twice as wide as the lateral ones (Lampert).

[a] Siboga Holothurioidea, p. 21.

[b] *S. godeffroyi* var. *b* of authors.

Color, olive brown (olive green, according to Lampert). A single madreporic canal and three Polian vesicles present. Deposits: Numerous C-shaped bodies; tables similar to the small tables of the following species, the truncate spire ending in eight to twelve, or even fourteen, teeth. Disk of tables small. Few incomplete rosettes are present. The pedicels contain spinous rods, very similar to those of *S. tropicalis*. The dorsal appendages are also strengthened by numerous curved, simple or branched rods. Rosettes are not recorded in typical examples.

The following is the distribution of this species as given by Théel and Lampert: Zanzibar (Selenka), Querimba and Mozambique (Semper), Indian Ocean (Ludwig), Mauritius (Haacke, Ludwig), Macassar (Ludwig), Lugunor and Guahan (Brandt), Sandwich Islands (Selenka), Pulo Tikul, Nicobar Islands, Pelew Islands, Molucca Islands, Samoa and Fiji Islands (Semper), Friendly Islands (Théel), and Darros Islands (Bell).

STICHOPUS TROPICALIS, new name.

Plate LXX, figs. 1, 1*a–i*.

Stichopus godeffroyi var. b SEMPER, Reisen im Archipel Philipinnen, Pt. 2, 1. Holothurien, 1868, p. 246.

Body cylindrical, elongate, flattened ventrally, arched dorsally, anteriorly untapered; slightly tapered but truncate posteriorly. Mouth anterior but ventral, surrounded by a fringed papillose collar; anus posterior. Mouth large; circle of tentacles, 20 in number, broad. Tentacles rather short; peltate; the crown convex. Pedicels numerous, disposed in three longitudinal bands on ventral surface, the median band twice as wide as the laterals. Papillæ scattered over dorsal surface. There are four rows (irregular) of very prominent protuberances, nearly as large as a small acorn in the living animal, a series along either side adjacent to ventral surface, and a row on both dorsal ambulacra. Small papillæ scattered over the interambulacra. Integument thick, very minutely roughened by spires of tables, especially on the conical protuberances, where the large tables are abundant. Deposits: Remarkably large robust tables with a conical spire ending in a single point, and much smaller tables of two or three sizes, with a small disk and a truncate spire terminating in eight to twelve points; besides these, C-shaped bodies and small dichotomously branched rods. In the pedicels and papillæ robust supporting rods, dilated and perforated at the middle. Color in life, tentacles, pale greenish gray to whitish; body dark olive green mottled with deep brownish green; in alcohol, dull yellow ocher. Length of preserved specimen, 160 mm.; breadth at anterior end, 32 mm.

Locality.—Honolulu Reef, outer edge (8 specimens); Puako Bay, Hawaii, tide pools (1 specimen).

In preserved specimens the tubercles, which are so characteristic and prominent in live animals, shrink to an insignificant size, except on the anterior end of the body. The collar near the edge is crowded with robust papillæ, which are smaller than the conical protuberances above noted. The papillæ of the interambulacra are scattered and average about 5 to 8 mm. apart. The four series of prominent protuberances are not very regular. In the ventro-lateral series there are twelve to fourteen, and on the two dorsal ambulacra usually two or three more. In the latter region the warts are often very irregularly placed. The tip terminates in a papilla. The pedicels are robust and have a terminal plate. The interval between the middle and lateral bands is equal to about half the width of the latter. In a carefully killed individual it is possible to distinguish a narrow area, running along the center of the ventral surface, free from pedicels, which thus divides the central area of pedicels into two parts. This line is, however, not nearly so conspicuous as the other two free areas. Pedicels extend up to the edge of the circumoral collar.

The calcareous ring varies somewhat with the size of the individual. The radial pieces are much larger than the interradial, and anteriorly the border has four blunt points; posteriorly two. In older individuals the posterior points are more prolonged. The anterior border of each interradial piece has a single point; the posterior border is deeply concave. Although Théel found two Polian vesicles in his Hawaiian specimen, there is but one in three examples I have examined. Madreporic canal and body single, lodged in dorsal mesentery. Gonad forms two tufts, one on either side of the mesentery. In one specimen, collected May 8, the gonad is very large. Respiratory tree very large, branches of the larger tube in connection with the vascular network of intestine.

The deposits are as follows: (1) Large tables, with a broad disk and tapering spire ending in a single or, rarely, in two or three points, and with two or three crosspieces. The spire varies considerably in length, but commonly lies between 0.12 and 0.19 mm. The disk is broad and is usually irregular in outline, rather longer one way than the other, and likewise varies much in size, 0.15 to 0.18 mm. being the average width. The numerous perforations vary from 0.003 to 0.015 mm. in width. These large tables are confined to the basal half of the papillæ of the dorsal and lateral surfaces, being absent from the ventral perisome. The points of the spires can be seen with a hand lens in preserved material, especially near the tips of the conical warts, where this sort of table is very abundant. (2) The small tables are abundant in both dorsal and ventral integument and measure about 0.04 to 0.05 mm. in height. The disk is small and subquadrate, with usually four peripheral holes at the base of the spire supports. The summit of the spire terminates in a variable number of teeth, often as

many as fourteen, but commonly only twelve. (3) Besides these there are still larger tables (Plate LXX, fig. 1*f*) of similar general appearance, but with the spire 0.08 to 0.1 mm. high and the disk about 0.08 mm. in diameter and with more numerous peripheral perforations. These are found at the bases of the papillæ, in a narrow zone, between the ordinary small tables and the large single-pointed variety. It is here that the large tables with two or three points or with the sides of the spire toothed are to be found, forming more or less perfect transitional stages. In the ventral perisome there are comparatively few tables without any, or with only rudimentary, spires. (4) Dichotomously branched rods, 0.03 to 0.04 mm. long, forming more or less incomplete rosettes, are common in the dorsal perisome, but appear to be absent from the ventral, or at least not numerous. (5) C-shaped bodies 0.09 to 0.14 mm. long are present in both dorsal and ventral perisome. (6) Besides these, near the tip of papillæ, and more abundantly in the pedicels, are stout supporting rods, more or less dilated at the center, and perforated. The edges of the rods are finely spinous. These supporting rods vary in length, averaging 0.35 to 0.5 mm. long in the ventral perisome, somewhat shorter in the dorsal, where they often lack the central plate-like expansion and have instead one or more branches with spinous margins. The terminal portion of each papilla is strengthened, not by the rods, but by perforated plates, about 0.9 mm. in diameter, the margins being irregular, often formed of spinous branches of incomplete trabeculæ. The perforations are relatively large. Thus, counting from the base of each papilla, the following deposits are found: Ordinary tables and rosettes, larger tables, transitional tables, conical-spired large tables, supporting rods, supporting plates.

This species lives in tide pools, and is found on the reef, between Honolulu and Waikiki, near the outer edge, where the pools are large and are not cut off from the ocean for any length of time. The animal is dark greenish and rather inconspicuous. One specimen was found to contain a fair-sized fish, *Fierasfer homei*, which had taken refuge in the large respiratory tree, and had its snout protruding through the anal aperture.

The species is apparently most nearly related to *Stichopus horrens* Selenka, from which it differs in having ambulacral appendages on the dorsal interambulacra, as well as on the ambulacra. From *Stichopus godeffroyi* it is distinguished by the C-shaped bodies, which are not found in that species. The present form has been known as *Stichopus godeffroyi* variety b, a cumbersome title, which does not indicate its true relationship. If the form is not a true species it would probably be united with *S. horrens* rather than with *godeffroyi*. There seems little doubt, however, that we have here a true species. *S. godeffroyi*,

lacking the C-shaped bodies, has not been detected in the Hawaiian group. Théel records the present species from the Friendly, Samoan, Fiji, and Pelew islands, and Lampert adds Cebu.

Subfamily SYNALLACTINÆ Ludwig.

Synallactinæ Ludwig, Mem. Mus. Zool., XVII, No. 3, 1894, pp. 8 and 26.

Genus MESOTHURIA Ludwig.

Mesites Ludwig, Zool. Anz., 1893, p. 79. Type, *M. multipes* Ludwig, *nomen nudum*.
Mesothuria Ludwig, Mem. Mus. Comp. Zool., XVII, No. 3, 1894, p. 31. Type, *M. multipes* Ludwig.

Body cylindrical or with slightly flattened ventral surface; no brim. Tentacles 12 to 20. Pedicels on lateral ventral radii always well developed; as a rule small on mid-ventral region (rarely absent); small, scattered and papilliform on back. Deposits: Tables. Body wall thin as a rule. Gonad in a single tuft on left of dorsal mesentery. No tenacle ampullæ. Longitudinal muscles undivided.

MESOTHURIA CARNOSA, new species.

Plate LXX, figs. 4, 4*a-f;* young, Plate LXXI, figs. 4, 4*a*.

Size rather large. General form cylindrical, oblong, tapering abruptly at either end. Body very limp and soft, but integument firm; dorsal body wall apparently thicker than ventral. Mouth terminal but directed ventralwards in life; anus terminal. Tentacles 18 to 20, with rather small peltate crowns. Ambulacral appendages in the form of small pedicels scattered rather thickly over the ventral surface, those of either ventrolateral ambulacrum somewhat larger than in midventral region, where they are very small; pedicels of dorsal surface few, widely scattered and small in size. Here and there are low thickenings of the integument suggesting wart-like swellings. Deposits: Tables of rather large size, very crowded, and composed of a broad disk, irregular in outline with numerous perforations, and a spire composed of four rods, one crossbeam (besides those of crown), and a crown of four upright often divergent teeth, with one to several smaller denticles on sides. In pedicels are comparatively very small tables with three or four uprights and reduced disks. Under the tables, and apparently in the subcutaneous muscle layer also, are smooth, scattered, simple, very delicate, and slender spicule-like rods. Apparently no supporting rods in pedicels. In oral disk and tentacles nearly straight to irregular spiny rods, 0.1 to 0.55 mm. long. (Plate LXX, fig. 4 *f*.) Color in life: translucent pinkish white, more or less stained with brownish, often dirty whitish or shade commonly called flesh color. Ventral surface is darker on account of leaden purplish muscle bands of mid-ventral ambulacrum showing through body wall. Tentacles translucent grayish white; crown mottled yellowish white

and grayish brown. Length of largest specimen, nearly fully extended (preserved in formalin), about 250 mm.

Localities.—Type (Cat. No. 21215, U.S.N.M.) from Station 4130, vicinity of Kauai Island, 283 to 309 fathoms, fine gray sand, bottom temperature 46.1°; 13 specimens. Taken also at the following stations (in all 50 specimens):

List of stations.

Station.	Locality.	Depth.	Nature of bottom.
3988	Vicinity of Kauai Island ...	469–195	Gray foraminiferous sand, pebbles.
3997	.....do.....	418–429	Fine gray sand, brown mud.
4021	.....do.....	286–399	Coral sand, foraminifera.
4041	West coast Hawaii Island ..	382–253	Gray mud, foraminifera.
4131	Vicinity of Kauai Island ...	309–257	Fine gray sand.
4132	.....do.....	257–312	Fine gray sand and mud.
4134	.....do.....	324–225	Fine coral volcanic sand.
4136	.....do.....	294–352	Fine coral sand.
4139	.....do.....	512–339	Fine gray sand, rocks.

As noted in the diagnosis above, the number of tentacles varies from 18 to 20, and is frequently 19. Branches of crown are all short, the latter being subcircular and rather flat topped. Width of circle of tentacles over all about 25 mm. Ambulacral appendages very scarce on dorsal surface and scattered, but at hinder end of body they become more numerous, yet remain inconspicuous. Over most of dorsal surface it is difficult to distinguish any pedicels at all without the aid of a glass; but some specimens appear to have more than others. The wart-like thickenings seem to represent much contracted papillæ possibly of a sensory nature, since they are more retracted than the pedicels. On median ventral region the pedicels are easy to see, but are very small, gradually increasing in size toward the ventral-lateral radii. In formalin specimens, which wonderfully retain the life appearance, the mid-ventral radial line is conspicuous owing to transparency of integument. Perisome is minutely roughened by spires of tables.

The calcareous ring is rather soft, and in alcoholic specimens is often much shrunken, giving an appearance of variability. Radial pieces much larger than interradial, with an abrupt deep notch on posterior border on either side of which is a little horn, forming an incipient posterior prolongation. This is apparently obsolete in some specimens. Anterior border has a central narrow notch and on either side a very shallow undulation. Interradial pieces with a prominent tooth anteriorly but not noticeably excavated posteriorly. One large Polian vesicle. Madreporic canal runs forward and upward in dorsal mesentery, the ovoid madreporic body being attached to body wall at anterior edge of mesentery. Ring canal and radial water canals between the former and calcareous ring large. No tentacle ampullæ extending into the body cavity, only rudiments, filling the anterior excavations in calcareous ring. Thus there are two larger ampullæ (interradial) alter-

nating with two smaller (radial), as Hérouard[a] has figured for his genus *Allantis*, but the tentacles do not differ a particle in size. Gonad forms a good-sized tuft on left side of dorsal mesentery. Intestine follows a long S-shaped course. Cloacal cavity large. Respiratory tree large, not in connection with intestinal vessel.

Tables are very crowded, the disks overlapping as much as possible, thereby bringing the spires unusually close together. In the general perisome there are tables with smaller and larger disks, the former about 0.08 to 0.1 mm. in diameter, the latter 0.13 to 0.15 mm. Smaller tables have a large central subcircular perforation and about eight to twelve primary peripheral ones. As the tables increase in size smaller perforations are interpolated at the end. Large disks have two to three series of holes. Margin of disks irregular and often, in large ones, produced into a few irregular tooth-like projections. The spire is composed of four (rarely three) rods; these, extending some distance above the transverse pieces of crown and often flaring somewhat, form the four prominent teeth of the crown. One or two accessory denticulations frequently occur near tip of primary tooth, and one tooth may be longer than the other three, especially in largest tables, thereby causing irregularity. Occasionally also a large tooth projects from the side of one or two of the rods near the crown beams; or a tooth may project from one or more of these transverse beams, but this is not common. The hole inclosed by the crown crossbeams is subcircular as seen from above. Spires of average tables are about 0.08 to 0.087 mm. in height. Pedicels apparently have no supporting rods, but their tables are much reduced in size, having a small annular disk about 0.056 mm. wide. The spire, made up of four or three uprights and one crossbeam, ends in four teeth, with occasionally an accessory horizontal tooth or two. At base of pedicels the tables are intermediate between this very reduced variety and the simpler forms of general perisome. As a rule the tables are variable (in same individual), scarcely two being alike, except in general features. This is especially true of larger disks, both the general contour and that of the perforations being subject to great variation. The figures will serve to show the typical forms. Beneath the tables occur very slender spicules of different lengths. They resemble sponge spicules very closely and are pointed at both ends or rounded. In length they range from 0.08 to 0.3 mm., or even more, in width from 0.002 to 0.004 mm. approximately. These spicules are scattered and appear to be a constant although inconspicuous part of the calcareous deposit. Terminal plates of pedicels resemble those of *Holothuria* rather more than the form figured by Ludwig for *Mesothuria multipes*. They are simple perforated plates with irregular outlines, often elliptical, about 0.28

[a] Holothuries provenant des Campagnes de la Princess Alice, Resultats Compag. Scientif. Prince Monaco, fasc. XXI, 1902, pl. 1, fig. 3 (*Allantis intestinalis*).

by 0.17 mm., although differing widely as to dimensions according to the size of the pedicel.

From *Mesothuria multipes* Ludwig, *M. lactea* (Théel), *M. thomsoni* (Théel), *M. murrayi* (Théel), *M. parva* (Théel), *M. marginata* Sluiter, *M. oktaknemus* Sluiter, and *M. holothurioides* Sluiter the present species differs especially in the form of the tables. These differences can be best appreciated by a comparison of figures. *M. marginata* and *M. holothurioides* have but three rods to the spire and the former has the spire ending in a long thorny point. *M. oktaknemus* has much less robust tables than *carnosa* with slenderer spire ending in longer points. The disks also are different. Other minor differences may be found in the distribution of pedicels and in the form of their terminal plates, although the latter feature may not be of any importance. In life *carnosa* is very soft and fleshy, almost jelly-like except for the firm perisome. This character is admirably retained in formalin specimens, but in alcohol, after the water is extracted from the tissue, the latter becomes thin and leathery. If it were not for this fact one might make comparisons in the character of the body wall of the different species. If one had only alcohol specimens of *carnosa* he would draw absolutely incorrect conclusions as to the appearance of the live animal.

From *M. abbreviata*, *M. incerta*, and *M. squamosa* Kœhler and Vaney, *carnosa* differs in the deposits and also in outward form.[a]

So far as the deposits are concerned, *carnosa* appears to be rather more closely related to *M. intestinalis* (Ascan.) as described and figured by Östergren[b], than to any other known member of the genus. As a comparison of figures will show, the deposits are very much alike, although the three and five rod spires appear not to be present in any specimens of *carnosa* that I have examined. The body wall of *carnosa* is thick and fleshy in life; that of *intestinalis* is described as thin; whether it is so in life I am unable to learn. *M. intestinalis* and *M. verrilli* are hermaphrodite, whereas in *M. carnosa* the sexes are separate.

There are two small specimens from Station 3839 (South coast Molokai Island, 259 to 266 fathoms, light brown mud, sand) much dilapidated, which have peculiar deposits (Plate VI, figs. 4, 4*a*). These specimens, much contracted and compressed, are about 30 mm. long, and so far as can be determined resemble *M. parva*. The disk of the tables is subcircular and pierced by a central and eight peripheral holes of nearly the same size. The spire is composed of four rods and one crossbeam, the crown ending in four slightly diverging spinous tips. Disks are usually not wider than 0.1 mm., and are commonly much more

[a] See Kœhler and Vaney, Deep-Sea Holothurioidea of the *Investigator*, 1905, pp. 10–14; pl. I, fig. 6; pl. IV, fig. 10; pl. IX, figs. 4–11; pl. XII, figs. 19, 20.

[b] Festskrift för Lilljeborg, 1896, p. 347, pl. XVIII, figs. 1–26.

regular than the figure. The specimens may be the young of this species. At least the tables approach nearer those of *carnosa* than those of *murrayi* or *parva*.

MESOTHURIA MURRAYI (Théel).

Plate LXXI, figs. 1, 1*a–h*.

Holothuria murrayi THÉEL, Challenger Holothurioidea, Pt. 2, 1886, p. 185, pl. x, figs. 16–18.

General form oblong, subcylindrical, tapering slightly toward anterior end; rather more so toward posterior extremity. Mouth and anus terminal, but the former directed ventrally. Tentacles 19 to 20, short, and with rather small circular peltate crowns. Ambulacral appendages in the form of different-sized, slender pedicels thickly scattered all over the body, those along either ventrolateral ambulacrum largest. Body wall rather thin in fully extended alcoholic specimens, very minutely roughened by spires of tables. Deposits: Tables with a large, open, subcircular, scalloped to substellate disk having a central subcircular hole and six to eight much larger ovate peripheral primary holes, and frequently in addition as many, or fewer, much smaller secondary perforations at the tips of the spokes separating the primary holes; spire made up of three rods and one crossbeam, flaring at summit, and each rod ending in two or three short multifid prongs. No supporting rods in pedicels, but very much reduced tables with a simple annular almost rudimentary disk and an irregular spire of three rods and one crossbeam. Color in alcohol, dirty whitish, brownish to purplish brown. Length of a preserved specimen, somewhat contracted, 95 mm.

Localities.—Thirty-five specimens were taken at the following stations:

List of stations.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3472*a*	South coast Oahu Island	295	Fine white sand.
3813	....do	264–183	Coral sand, lava specks, shells.
3866	Pailolo Channel, between Molokai and Maui.	283–284	Gray mud, fine sand.
3883	....do	277–284	Globigerina ooze.
4088	North coast Maui Island	308–306	Fine gray sand.
4096	Northeast approach, Pailolo Channel	272–286	Do.

a Cruise of 1891, 3 specimens.

Since no specimens of this species were kept in formalin, it is not easy to surmise the form of the living animal. Breadth of circlet of tentacles about 10 to 12 mm. A characteristic feature of this species is the diversity in size of pedicels, those along either ventrolateral ambulacrum being much larger than any others and forming a well-defined band. The smaller, more or less papilliform, slender pedicels

of dorsal surface are rather numerous and are of several sizes, but all smaller than the ventrolaterals. Pedicels of mid-ventral region small and inconspicuous, and frequently more or less completely retracted into body wall.

Radial pieces of calcareous ring considerably larger than interradial, posteriorly rather deeply excavated, the anterior border with three notches, the central the deepest (lateral ones sometimes very small). Interradials are not excavated posteriorly, and have a prominent tooth anteriorly. Madreporic canal runs forward in the dorsal mesentery and gradually upward, the madreporic body being fastened to the body wall at the anterior edge of the mesentery. Polian vesicle single. No tentacle ampullæ extending into body cavity, the rudiments of these merely occupying the space in front of the calcareous ring. The "ampulla" on either side of the anterior tooth of interradial piece is much larger than those of radial pieces, as in preceding species, in consequence of difference in size of the component parts of calcareous ring; but there is no corresponding difference in size between the tentacles. Gonad forms a large tuft on left side of mesentery. Respiratory tree well developed. Intestine follows a simple S-shaped course. Longitudinal muscle bands rather small.

The disks of the larger tables of general perisome have a width of 0.135 to 0.18 mm., and the spires a height of 0.10 to 0.15 mm. In outline the disks are often fairly regularly scalloped (Plate LXXI, fig. 1*h*), especially when there are no secondary perforations. The primary peripheral holes are always larger than the central and are commonly ovate in outline, or subcircular. The secondary perforations are formed by the forking of the spokes separating the primary holes. The framework of disk is rather delicate, the spokes being heavier than rim. The spire flares more or less toward the summit, and the three rods terminate in two (sometimes three) irregular denticulate prongs; or the prongs are occasionally obsolete. The amount of divergence of the terminal portion of rods and the distance between their tips and the point where the three meet is subject to some small variation, the figures showing two typical examples. (Plate LXXI, figs. 1*a–b*.) The distance between the disk and crossbeam is always less than the distance between the latter and the point of divergence of the crown prongs (which depart from one point, as it were, since there is no hole between them, as is usually seen when viewing a table from above). In the walls of the pedicels the tables are small and irregular, as well as variable, many of them being reduced to lowest terms. The disk is a simple ring (no peripheral perforations) from which arise the three spire supports, which commonly terminate in a cluster of blunt teeth or in one or two sharp ones. The teeth are scattered along the side of terminal portion of the rod. Terminal plates of pedicels vary in size. They are simple circular perforated

plates, the perforations of center being largest and the edge more or less ragged from incomplete perforations. Sometimes there is a large central hole. In the smaller plates the perforations are more irregular as to size and shape, the trabeculæ often being uneven in diameter. Diameter of plates range from 0.13 to 0.28 mm.

These specimens, if not actually *M. murrayi*, represent an exceedingly close relative. Some slight differences are discernible. For instance, the tables of Hawaiian specimens usually have larger disks, the framework of which is more delicate than in Théel's types, and the form of the crown presents a few minor points of difference, as can be appreciated by a comparison of figures. The deposits, however, are very variable, and the robustness of the tables seems to be at least partially correlated with the softness of the mud and sand upon which the creatures dwell, the more delicate tables being found in specimens taken from ooze or soft mud. Disks such as *h* (Plate LXXI, fig. 1) will be found in some parts of the perisome (usually near extremities of body) while 1 and 1a will be present in other parts. But some examples present a great predominance of the "*h*" type (without secondary perforations), while others will have the "1" type in greatest abundance. One or two specimens have the tables decidedly irregular, but are otherwise normal. Hawaiian specimens apparently have more dorsal pedicels than Théel's types, but this is a hazardous conclusion to draw from the description, however good the latter may be. Despite these small differences, which may be of specific importance, I prefer to range the specimens under *murrayi* and call attention to discrepancies. When a critical comparison of specimens from widely separated localities can be made, it may be desirable to recognize several nearly related species, which are now grouped under this name. Sluiter[a] has recorded the species from 400 and 522 meters in the East Indies, while Théel's types came from 1,375 fathoms, globigerina ooze, near Juan Fernandez. He also mentions, with doubt, a specimen from off the Straits of Gibraltar, but Hérouard[b] records the species from near the Azores, thus confirming the presence of the form in the Atlantic.

As to the relationship of this with the following species a rather knotty problem arises. A few notes will be found under *Mesothuria parva*.

[a] Die Holothurien der Siboga-Expedition, 1901, p. 24.

[b] Holothuries provenant des Campagnes de la Princess-Alice, Résultats Campag. Sci. Prince Monaco, fasc. XXI, 1902, p. 23.

MESOTHURIA PARVA (Théel).

Plate LXXI, figs. 2, 2*a–c*.

Mesothuria murrayi var. *parva* THÉEL, Challenger Holothurioidea, Pt. 2, 1886, p. 187, pl. IX, fig. 2; pl. XVI, figs. 4, 5.

General form and appearance almost exactly like that of preceding species. Tentacles 18 to 20. Pedicels of divers sizes scattered all over body, those of ventrolateral ambulacra largest, there being one or two irregular series especially large. Median ventral pedicels extremely small and scattered, often very few in number; those of dorsal surface smaller than ventrolateral and fairly uniform as to size, though some difference is discernible; pedicels, on the whole, rather less numerous than in preceding species. Body wall rather thin. Perisome roughened by spires of tables. Deposits: Tables composed of a large disk with a central and numerous peripheral perforations, and a spire of three rods with spinous apices; one cross beam. (For shape of deposits see Plate LXXI, fig. 2.) No supporting rods to pedicels, whose tables are much reduced in size. Color in alcohol either yellowish white or purplish gray. Length about 95 mm. or less.

Localities.—Forty specimens from following stations:

List of stations.

Station.	Locality.	Depth.	Nature of bottom.
3895	South of Molokai Island	252–429	Coral rocks.
3919	South coast Oahu Island	257–220	Gray sand.
3998	Vicinity of Kauai Island	235–228	Coarse brown coral sand, shells, rocks.
4081	North coast Maui Island	202–220	Gray sand, foraminifera.
4115	Northwest coast Oahu Island	195–241	Coral sand, foraminifera.
4122	Southwest coast Oahu Island	192–352	Coarse coral sand, shells.

Label lost from one bottle of 20 specimens.

The internal organization presents no marked points of difference from that of the preceding species. The calcareous ring is of the same general form; tentacle ampullæ same. The ring canal and proximal portion of the radial canals are large. Polian vesicle single. Madreporic canal, gonads, and respiratory tree practically identical with those of *M. murrayi*.

The tables differ from those of the preceding species in being much crowded. They overlap markedly as in *M. carnosa*, whereas in *M. murrayi* they are not nearly so closely placed. Besides the difference in form, which is more readily appreciated by a comparison of figures, the disk in *M. murrayi* is frequently considerably larger. The disk in *M. parva* is more robust, with a greater number of perforations, and the spire is lower and stouter, the crown being more compact and variable. Typical *parva* as figured by Théel has no central perforation in the crown, as is frequently the case with Hawaiian examples. Diameter of disk averages about 0.12 mm., height of spire about 0.085 mm.

Externally the species is practically indistinguishable from the foregoing. Some specimens of *parva* have apparently fewer pedicels on the midventral region, and less diversity, especially in small individuals, in size of dorsal pedicels. The species can always be readily separated, however, on the character of the tables. It will be noticed that *parva* lives on a hard bottom and *murrayi* on a soft. Just how much significance this fact has in accounting for differences in the structure of the calcareous deposits it is impossible to say. These two species exemplify very well one of the difficulties which constantly besets a systematist. Taking the specimens as a whole, two views are possible concerning them: (1) That the two forms represent one variable species; (2) that the two forms are specifically distinct. In the present case, (1) have we one variable species which differs widely according to the nature of its particular environment, whether it be soft, oozy mud, or hard sand and shells; or (2) have we two closely related but distinct species, each dwelling on a different sort of bottom? I have followed the latter view, since there appear to be no intermediate forms, and since I have no difficulty in separating the species, upon an examination of deposits. That the forms are very close is manifest; but it is a well-known fact, not generally appreciated, that all species are not necessarily separated from their nearest congeners by the same degree of difference. In the present case the question also arises as to whether these two species are to be identified with already known but distantly dwelling forms, or are to be regarded as new but closely allied kinds. Since this has to be decided by literature and not specimens I have chosen the more conservative course, although it may not be the correct one.

Mesothuria parva was taken by the *Challenger* in 150 fathoms, coral mud, near Admiralty Island.

Genus BATHYPLOTES Östergren.

Bathyplotes Östergren, Zur Kenntniss der Subfamilie Synallactinæ unter den Aspidochiroten, Zoologiska Studier, Festsch., Wilhelm Lilljeborg, 1896, p. 351. Type, *Stichopus natans* Sars.

Mouth ventral to subventral, anus subdorsal to nearly terminal. Ventral surface more or less flattened, with the rows of pedicels on all three or only on the two lateral ambulacra. Dorsal surface arched with a double row of papillæ along each radius, and often besides with small papillæ scattered sparingly over the interradii. Dorsal papillæ sometimes very irregular in distribution and a ventral-lateral series in addition to pedicels sometimes present. Tentacles 15 to 20. Gonad in two tufts (a right and a left). Longitudinal muscles undivided. Calcareous deposits: Tables with usually a four (three to eight) armed disk, bearing a spire of an equal number of rods; C-shaped spicules usually present.

BATHYPLOTES PATAGIATUS, new species.

Plate LXXII, figs. 1, 1*a–k*.

Body rather long and narrow, truncately rounded at either end; ventral surface flattened; dorsal somewhat arched in life. Mouth terminal but ventral; anus dorsal. Tentacles 19 to 20, rather small; crown subcircular, peltate. Median ventral ambulacrum without pedicels. A single, somewhat irregular series of numerous small pedicels along each ventrolateral ambulacrum, and immediately above these, on edge of body, another series of numerous small, warty excrescences, terminating each in a slender papilla. These form a narrow, overhanging brim to body, especially well marked at anterior end. On dorsal surface are widely scattered, fair-sized conical protuberances, terminating in a long, slender papilla. In life body wall is rather of a thick "jelly-fish" consistency, the external perisome being easily rubbed off. Deposits: In ventral perisome tables with small annular disk, sometimes incomplete, and a spire composed of four upright pieces, three to five crossbars and a crown ending in four simple teeth; in the dorsal perisome disk is transformed into a four-armed cross, perforated at tips, and the spire is frequently spiny along uprights. At base of papillæ disks are greatly enlarged, the ends of the four-armed crossbeam being much dilated, and the spires are also stouter and spiny on uprights. In papillæ the spires are very tall, with as many as nine or ten crossbeams, the disk becoming reduced by degrees to the annular form. In papillæ curved, spiny supporting rods in addition to tables; in pedicels well-developed terminal plates and small tables, similar to those of ventral perisome, in addition to a very few supporting rods near the end plate. In subcutaneous muscle layer, in walls of gonad, of cloaca, and intestine numerous C-shaped bodies are present. Color in life, outside jellylike tissue transparent grayish, with a tinge of pink, the central "core" of animal being bright rose pink, with a yellowish shade in places. Length, 155 mm.; breadth, 14 to 20 mm.

Localities.—Type (Cat. No. 21216, U.S.N.M.) from Station 4041, west coast of Hawaii Island, 382 to 253 fathoms, gray mud, foraminifera; bottom temperature 41.6°. Cotype (deposits), 3994, vicinity of Kauai Island, 330 to 382 fathoms, fine gray sand, foraminifera. Taken also at the following stations, 14 specimens, most of them in very poor condition:

List of stations.

Station.	Locality.	Depth.	Nature of bottom.
		Fathoms.	
3821	South coast of Molokai Island	222–498	Coral rocks, broken shells.
3988	Vicinity of Kauai Island	469–165	Gray foraminiterous sand, pebbles.
4021	.....do	286–399	Coral sand, foraminifera.
4134	.....do	324–225	Fine coral sand and volcanic sand.
4140	.....do	339–437	Fine gray sand.

Owing to the fact that the animals have rid themselves of most of their viscera it is difficult to tell exactly what the life habit may have been. The body is much depressed, and on the best preserved specimen the narrow serrate brim is easily seen. This is especially well marked in the vicinity of the anterior end, and causes the mouth to be ventral. The marginal papillæ are here close together but farther caudad are more spaced. They arise from fairly broad conical bases and are about 2 to 3 mm. in length. Pedicels are about same length and have a well-developed terminal disk. Pedicels and lateral papillæ are apparently in about equal numbers, although on account of injuries to the margin some of the latter have been rubbed off. Dorsal papillæ are larger than the laterals, being about 4 to 5 mm. long in a contracted state. Although found in the neighborhood of each dorsal ambulacrum they are not at all regularly arranged, sometimes forming transverse rows of three or four, or occurring isolated here and there in the middorsal region.

Calcareous ring is rather small, the interradial pieces being very much reduced. The figure (Plate LXXII, fig. 1*j*) will sufficiently show the form. Madreporic canal single, running forward in dorsal mesentery to become attached by the madreporic body to body wall at anterior edge of mesentery. Ring canal and proximal portion of radial canals conspicuous. No tentacular ampullæ hanging free in body cavity. Polian vesicle single, large. Gonad divided into a right and a left tuft. Tubules twice dichotomously branched, their walls containing C-shaped deposits. Respiratory trees fairly well developed, composed of a right and left branch springing from a common base and over half as long as animal. Wall of cloaca crowded with C-shaped deposits, which are present also in the wall of intestine, but in not nearly so great numbers. Longitudinal muscle bands single, ribbon-shaped.

In the type specimen the calcareous deposits have been severely injured by acid. The figures have been drawn from deposits of a smaller specimen, which is much contracted and distorted. Most of the perisome had been scraped off of specimens from this station. The tables of the ventral perisome are smaller and simpler than those of papillæ and their intermediate neighborhood. These tables have usually an annular disk with four large holes formed by the simple diagonal bars, but occasionally the ring is incomplete, or one or more small peripheral holes may be present, as indicated in the figures. (Plate LXXII, figs. 1, 1*b*.) Disks of this type measure 0.046 to 0.08 mm. in diameter, and the spires (fig. 1*d*) are commonly 0.067 to 0.09 mm. high, with three to five crossbeams. The interval between the first and second beams is always greater than that between the others. The upright pieces are nearly parallel and terminate in four simple teeth. These tables are commonest in the ventral and lateral peri-

some, but whether they are confined wholly to this region it is impossible to say on account of the condition of available specimens. Tables of the dorsal perisome are of the type shown in fig. 1*a*, Plate LXXII. The disk is a four-armed cross, with the tips of the arms slightly expanded and one to five times perforated. The spire rods are toothed on the upper half, the spire itself being about 0.12 to 0.15 mm. high, with five crossbeams. Rarely the teeth are absent. At the bases of the large dorsal papillæ, and to a less extent of the laterals also, are relatively very large tables with four-armed disks and robust spiny irregular spires. (Plate LXXII, fig. 1*c*, *e*, *g*.) The disks are from 0.3 to 0.47 mm. in diameter, and the ends of the arms are much expanded and perforated. The general form of the tables is sufficiently indicated by the figures. The spire of this table is 0.2 mm. high, but there is considerable range on both sides of the dimension. The tables in the papillæ proper are more of the type of those of ventral perisome, although much exaggerated in height (fig. 1*f*). They are usually numerous and grade into the type of *a* and *c* at base of papilla. The spire is usually about 0.17 to 0.2 mm. high. Scattered among these tables are relatively few supporting rods with spiny tips (1*i*, 1*k*) about 0.5 mm. long. So far as examined the pedicels have scattered tables similar to fig. 1*d*, but with only one or two crossbeams. Frequently two or three supporting rods are present near terminal plate, though they may be entirely absent. The terminal plate is large, circular, and perforated.

This species is characterized by the distribution of the ambulacral appendages, by the presence of a narrow but easily detected margin or brim to body, by the form of the tables, and by the form of the calcareous ring. It differs from all known species by the form of the calcareous deposits. Sluiter (Siboga Holothurioidea) has described *B. sulcatus*, *B. rubicundus*, *B. monoclus*, and *B. phlegmaticus* from the East Indian region. The present species is apparently nearer *phlegmaticus* than any of the others, but differs in all the categories of characters mentioned above, besides having 20 tentacles while *phlegmaticus* has 15. Kœhler and Vaney have described from the *Investigator* collections, *B. profundus*, *B. crenulatus*, *B. assimilis*, *B. variabilis*, and *B. papillosus*. The deposits of all of these are different from those of *patagiatus*.

Patagiatus is more or less closely related to *B. natans* (Sars) which it resembles in the marginal papillæ and brim, but differs in numerous details of deposits, etc. (for figures of *natans*, see Östergren).[a]

[a] Zur Kenntniss der Subfamilie Synallactinæ unter den Aspidochiroten.

Genus PSEUDOSTICHOPUS Théel.

Pseudostichopus Théel, Challenger Holothurioidea, Pt. 2, 1886, p. 169. Type, *Pseudostichopus mollis* Théel.

Tentacles 19 to 20; no tentacle ampullæ; madreporic canal attached to body wall; ventral surface flattened (more or less); ambulacral appendages in the form of unusually small, inconspicuous pedicels and papillæ which are more or less clearly arranged in longitudinal series; gonad in two bundles (a right and a left); anus in a perpendicular furrow, without teeth; perisome without calcareous deposits, except in some species about anus; pedicels with terminal plates and deposits in one species; deposits sometimes present in walls of genital tubes and respiratory tree.

PSEUDOSTICHOPUS PROPINQUUS, new species.

Plate LXXI, figs. 3, 3*a–b*; Plate LXXII, figs. 2, 2*a*; Plate LXXIII, fig. 3; Plate LXXIV, fig. 1; Plate LXXVI, figs. 3, 3*a–b*.

Contour of body as viewed from above or below rather broadly elliptical; ventral surface slightly arched, dorsal surface decidedly so. Mouth directed ventrally, but terminal. Anus in a prominent vertical furrow at extremity of body; more ventral than dorsal. Anal furrow, caused by the body growing caudad on either side of anus, forming two prominent mammillated processes. Tentacles 18 (to 20 ?) with small circular peltate crowns; entirely retracted. Ambulacral appendages for the most part very inconspicuous and small, in the form of minute pedicels (?) and papillæ scattered along ambulacra; those of either ventro-lateral ambulacrum most prominent on account of a single irregular row of small mammiform tubercles extending from caudal process forward, and connecting with series of opposite side in front of mouth. In addition, minute, thread-like papillæ are scattered on either side of these tubercles which are capped by very slender pedicels or papillæ; and a very few are to be found in mid-ventral region; papillæ of dorsal ambulacra very slender, long, and thread like; apparently not regularly arranged. Perisome devoid of any calcareous deposits; no supporting rods or terminal plates in ambulacral appendages. Walls of gonad and respiratory trees contain branched rods. Body wall translucent, rather thin except along either edge, which is thickened by a subcutaneous jelly-like substance, forming a sort of rim to the body. More or less mud, sponge spicules, and foraminifera cling to integument, especially on ventral surface. Color in alcohol, translucent whitish. Length of largest specimen, about 50 mm.; width, about 25 mm.

Locality.—Station 3866, northeast approach to Pailolo Channel, between Maui and Molokai islands, 283 to 284 fathoms, gray mud, fine sand; bottom temperature 43.8°; 2 specimens.

Type.—Cat. No. 21217, U.S.N.M.

On account of the tentacles being entirely retracted, as well as small, it is difficult to compute the number exactly; 18 were found, but it is entirely probable the number is as high as 20. Crowns of tentacles are of the usual aspidochirot form. The mouth is decidedly ventral when tentacles are retracted. It is encircled in front (but not caudad) by the continuous series of small tubercular papilliform processes which mark the ventro-lateral ambulacra. Each of these processes is surmounted by one or sometimes two slender papillæ. When retracted partially they resemble pedicels. There appear to be numerous pedicels also, however, as determined by microscopic examination. The absence of any terminal plate in the ambulacral appendages as well as their small size renders any distinction rather risky. In the smaller specimen I was able to make out a number of very small papilliform pedicels along mid-ventral region, where the longitudinal muscle shows through body wall in larger example, but in the latter only a very few exceedingly minute pedicels are discoverable. Scattered along either side of the more prominent ventro-lateral pedicels and papillæ are numerous smaller very inconspicuous ones, to be seen readily only with a bright light and a strong glass. No regular arrangement can be made out. Along the two dorsal ambulacra are scattered a few long, very slender papillæ, which appear to form a double row in the anterior portion, at least. Some of these papillæ are very thread-like. On account of the difficulty in seeing them it is impossible to give a thoroughly accurate account of their arrangement. A few in anterior portion of body, just behind the supraoral collar, are larger than the rest.

The calcareous ring is a trifle variable and irregular. The dorsal radial pieces seem a trifle heavier than ventral and differ slightly in shape. The component pieces are delicate and readily injured. The form is seen better by figures (Plate LXXII, figs. 2, 2*a*) than description, both dorsal and ventral being shown. Some radial pieces have a slightly more deeply excavated posterior margin, but, as a rule, it is shallow (fig. 2*a*). Polian vesicle single. Madreporic canal minute, running forward in dorsal mesentery below genital duct; no madreporite was discovered. Ring canal large; proximal portion of radial canals large. No tentacle ampullæ, except mere rudiments. Gonad consists of about ten unbranched slender tubes on either side of dorsal mesentery, which is more or less perforated in this region. Eggs are fairly well developed, so this specimen is probably mature. Respiratory trees, two, springing from a common base. Longitudinal muscles form a single cylindrical band along each radius. Intestine large, gorged with mud and sand.

The only calcareous deposits are those contained in walls of gonad and respiratory tree. They are irregular branched rods, smooth

except for an occasional spine. No two are exactly alike. Those of gonad are apparently larger than those of respiratory tree. The former measure from about 0.09 mm. up to 0.22 mm., while the latter seldom exceed 0.12 mm. in length. Rarely a small rod is unbranched. The figures will give a good idea of typical shapes.

This species is probably closely related to *Pseudostichopus mollis* Théel. It differs, apparently, in having a row of small but fairly conspicuous wart-like processes forming an inconspicuous fringe, as shown in the figure. The calcareous ring is of a slightly different form, and the calcareous deposits of genital and respiratory tubes are more branched and smaller. The dimensions may vary with age, however. The dimensions given by Ludwig[a] are about twice as great as those attained by deposits in this species. The internal organs are much as described by Théel and Ludwig for *mollis*. This species differs, by the presence of the deposits, from *Pseudostichopus trachus* Sluiter and *Pseudostichopus pustulosus* Sluiter from the East Indian region. *Pseudostichopus occulatus* von Marenzeller from the region of the Azores resembles this form in its deposits, but differs in the outer character of form, distribution of ambulacral appendages, etc., as well as in the presence of end plates in pedicels and deposits around the anus.

Genus PÆLOPATIDES Théel.

Pælopatides Théel, Challenger Holothurioidea, Pt. 2, 1886, p. 154. Type, *P. confundens* Théel.

Tentacles 12 to 20, peltate, or subdigitate on the margin of crown; no tentacle ampullæ; body more or less depressed often with a conspicuous overhanging border bearing a single series of numerous papillæ; this border or brim obsolescent in some species except at fore and hind ends of body; pedicels form a double row on hinder third or two-thirds of mid-ventral radius, and in some species also a single row along either ventro-lateral radius, in addition to papillæ; single series of papillæ on dorsal ambulacra; gonad in two tufts, a right and a left; mouth ventral; anus dorsal or subdorsal. Deposits, when present, simple, triradiate or four-armed rods, either smooth or spiny, with slightly branched tips; deposits often entirely wanting. A rete mirabile sometimes present.

PÆLOPATIDES RETIFER, new species.

Tentacles, 19 to 20, rather large; crown subcircular, fleshy, four or five times divided, peltate. General form short and stout; length two and one-half to four times width. Ventral surface more or less flattened, the dorsal markedly convex. Mouth ventral, anus dorsal. Mid-ventral radius with a double row of good-sized, spaced pedicels (about 28)

[a] Mem. Mus. Comp. Zool., XVII, No. 3, 1894, p. 12.

which extend about two-thirds length of animal, from posterior end. Along each ventro-lateral radius is a series of about ten rather large pedicels which extend from posterior end to about middle of body. Above these on edge of body is a single continuous series of papillæ, which form a conspicuous brim only at anterior and posterior extremities, above mouth and below anus, respectively. Along each dorsal ambulacrum is a fairly regular series of widely spaced, slender papillæ usually difficult to discern. Body wall thick and jelly-like in life. External perisome very thin and easily rubbed off. No calcareous deposits of any description. *An extensive rete mirabile present.* Color in life, the mass of soft jelly-like tissue a milky pinkish, becoming a pale pinkish lilac about mouth and tentacles; viscera show a yellowish tinge through the translucent body wall; purple about tentacles, sometimes deeper in shade; perisome minutely dotted with dark purplish, the dots being numerous, but very inconspicuous unless examined with a glass. Length, 135 mm.; breadth, 35 mm.

Localities.—Type (Cat. No. 21218, U.S.N.M), Station 4151, vicinity of Bird Island, 800 to 313 fathoms, fine coral sand foraminifera, stones; bottom temperature, 38.8°. Cotype, Station 4110 Kaiwi Channel, between Molokai and Oahu islands, 449 to 460 fathoms, gray sand. Taken at following stations, in all 23 specimens, the majority very imperfect:

List of stations.

Station.	Locality.	Depth.	Nature of bottom.
3887	North coast Molokai Island	552–809	Globigerina mud.
3979	Vicinity Bird Island	222–387	Fine white sand, foraminifera, rocks.
3995	Vicinity Kauai Island	427–676	Fine gray sand, rocks.
4019	.....do	550–409	Gray sand, foraminifera, rocks.
4022	.....do	399–374	Coral sand, foraminifera, rocks.
4028	.....do	444–478	Gray sand globigerina.
4038	West Coast Hawaii Island	689–670	Gray mud, foraminifera.
4039	.....do	670–697	Do.
4141	Vicinity Kauai Island	437–632	Volcanic sand, foraminifera.
4176	Vicinity Niihau Island	672–537	Gray sand, mud, foraminifera.
4187	Vicinity Kauai Island	508–703	Gray sand, foraminifera.

Most of the specimens are badly dilapidated on account of the extreme delicacy or softness of the outer portion of the body wall. Rough usage in the dredge has removed a large part of the perisome and many of the pedicels, papillæ, and even tentacles from the majority of specimens. The diagnosis and description are gathered from three specimens, reasonably well preserved. The absence of deposits makes the identification of this species a difficult matter, but I believe I am justified in considering it a new form, in view of the differences which appear to exist between it and its apparent nearest relative. The form of the body varies with the state of contraction, but seems to be thickest in the middle, the anterior and posterior ends being bluntly rounded, the former with a well defined rim of papillæ. Although the mouth is ventral, it is at the end of the body and is surrounded by a fairly broad peristome. The tentacles are about 5 to 8 mm. long, unless

contracted, and are surrounded by a narrow rim or collar independent of the papillæ and very inconspicuous. The crowns of the tentacles remind one of miniature cauliflowers. Pedicels of mid-ventral radius are usually retracted flush with level of perisome so that it is difficult to get an idea of their size. They are not exactly paired, but seem to alternate in the two rows. Between the anterior end of these series and the mouth I was able to discern, in one specimen, three or four widely separated, much smaller pedicels which seemed to continue the two series. The larger pedicels are about 8 mm. apart and the two series about 6 mm. Pedicels of lateral radii are wholly ventral in position and appear to increase in size as they proceed forward. In the only specimen in which they are at all expanded they appear to spring from a rather fleshy base, are about 6 mm. long, and appear larger than mid-ventral pedicels. As noted in the diagnosis this series does not extend farther forward than middle of body. Separated from the pedicels by about 6 or 7 mm. is the continuous series of numerous papillæ which form a border completely around body, but well marked only in the anterior and posterior portions. This border is very delicate and has been scraped off of the majority of specimens along sides of body. The only ambulacral appendages, therefore, on the lateral radii in anterior half of body are the papillæ. These are more numerous in the posterior half than the adjacent pedicels, are slender, and not particularly conspicuous. In vicinity of mouth the papillæ are about 10 to 12 mm. long, purple in color, and two or three appear often to spring from a common base, although this appearance may be due to injury. Papillæ along sides of body are very numerous, but on account of frequent imperfections it is impossible to ascertain exact numbers. It must be remembered that these papillæ do not form along the edge of the body such a conspicuous rim as is present in *P. confundens*. In fact, a brim is apparent only at the two extremities. Neither can the mouth with tentacles be retracted as is apparently the case with *confundens*. The longest dorsal papilla near anterior end of body is 18 mm. and very slender. The papillæ appear to decrease in size as they proceed caudad.

No calcareous ring. Madreporic canal single, in dorsal mesentery. No free tentacle ampullæ. Polian vesicles two, of about equal length, 40 mm. long; in one specimen of somewhat unequal length. Tissue between ring canal and base of tentacles dotted with purple. Gonad in two tufts, the tubules once dichotomously branched. Intestine with a large, lobed, fleshy diverticulum about 25 mm. behind ring canal. Respiratory tree very large, the right branch when perfect reaching as far forward as ring canal. The tube is large and the side branches, which are scattered along its whole length, have also rather wide tubes, ending in more finely branched dendritic vesicles. The left tree is not quite half so long as the right, but is much more intri-

cately and fully branched, having a very bushy appearance. It is in relation with an extensive and conspicuous rete mirabile of the intestine. This rete mirabile, which is as well developed as in some species of *Holothuria*, begins about 30 mm. behind the diverticulum of intestine and extends over 100 mm., occupying nearly all of the first large, backwardly directed U-shaped tract of the intestine. The vessels of the plexus are wonderfully numerous, being larger in the anterior portion of the rete mirabile than in the posterior (with reference to intestine, since the morphological posterior end of plexus is a little anterior to the front end, on account of U-shaped twist of alimentary canal). Longitudinal muscle bands divided, the mid-ventral strand the narrowest, the two dorsal remarkably wide, about twice as wide as the mid-ventral. The ventrolaterals are intermediate in size. Cloacal dilation is large, extending about 40 mm. forward from anus.

This species differs from true *Pælopatides* in two very important particulars, namely, in the possession of ventrolateral pedicels in the hinder half of body (these being absent in typical *Pælopatides*) and in having a well-developed rete mirabile. One of the characters given for the subfamily Synallactinæ is the absence of a rete mirabile. There can be no doubt, however, that the present form is a *Pælopatides* or nearly related genus, because the outward habit, lack of free tentacle ampullæ, two unequal Polian vesicles, large intestinal cœcum, and absence of calcareous deposits all point to it. I am not so sure that the type of the genus is without a rete mirabile, for Théel says[a] in the description of *confundens:* "The left [respiratory] tree is shorter but more branched, its ramifications being in communication with the plexus of pseudhæmal vessels. The right tree attains almost the length of the body itself." So far as the trees are concerned this agrees exactly with *retifer*. Ludwig makes no comment on this in his diagnosis of the Synallactinæ. His specimens of *confundens* seem to have lost the left tree and most of intestine, so that naturally the rete mirabile would be missing. Sluiter, who lists *P. confundens* in his Siboga Holothurioidea, does not mention the rete mirabile or make any reference to the apparently unnoticed remark of Théel above quoted. Inasmuch as Sluiter's specimens lacked the intestinal diverticulum I think there are grave doubts as to their being true *confundens*. Théel's type came from off the coast of Chile, in the latitude of Valparaiso, while Sluiter's specimens were taken in the distant East Indian region (between 116° and 132° E., and 0°–8° S.). *Retifer* appears to be distantly related to *P. purpureo-punctatus* Sluiter. It differs from this form in having a single continuous series of papillæ all along the ventrolateral radii, in addition to about ten large pedicels, which form a separate series parallel with the above

[a] Challenger Holothurioidea, Pt. 2, p. 156.

in the hinder half of body. In Sluiter's species there is a single row of about thirty large pedicels all along these radii, and in addition numerous scattered slender and smaller papillæ and pedicels which do not appear to form a single series as in *retifer*. The lateral pedicels of *purpureo-punctatus* are apparently larger than in *retifer*, and there is no fringe of papillæ under the anus as in *retifer*; neither is the body wall so thick and jelly-like. Kœhler and Vaney have created a genus *Bathysona*, to which this species is possibly referable. *Bathyzona* has the general form of *Pælopatides*, but the pedicels instead of being limited to the medium radius of the ventral surface, form 4 distinct rows, two median and two lateral, the latter near the border. Type is *B. incerta* Kœhler and Vaney, which has 9 tentacles and triradiate calcareous bodies not unlike those of *Pælopatides*. The internal organization is unknown. *Pælopatides purpureo-punctatus* is by no means typical, but does not seem to be referable to *Bathyzona*. Until the anatomy of this genus is better known I prefer to rank *retifer* in *Pælopatides*. The distribution of pedicels in connection with the absence of deposits will serve easily to distinguish it from any species referred to *Pælopatides*.

Family ELPIDIIDÆ Théel.

Elpidiidæ Théel, Challenger Holothurioidea, Pt. 1, 1882, p. 10.—Ludwig, Mem. Mus. Comp. Zool., XVII, No. 3, 1894, p. 39(=*Elasipoda* Théel).

Subfamily DEIMATINÆ (Théel) Ludwig.

Deimatidæ Théel, Challenger Holothurioidea, Pt. 1, 1882, p. 60.
Deimatinæ Ludwig, Mem. Mus. Comp. Zool., XVII, No. 3, 1894, p. 63.

Genus SCOTODEIMA Ludwig.

Scotodeima Ludwig, Mem. Mus. Comp. Zool., XVII, No. 3, 1894, pp. 74, 75. Type, *S. setigerum* Ludwig.

Twenty moderately large tentacles; along each ventrolateral radius a double row of large pedicels, and above them a series of long slender nonretractile papillæ (flank-papillæ); a double row of similar papillæ on each dorsal radius; median ventral radius with a few scattered smaller pedicels; mouth and anus ventral. Deposits: Stout simple rods and four-armed rods, more or less modified; all deposits of relatively large size. The genus stands between *Orphnurgus* and *Oneirophanta*.

SCOTODEIMA VITREUM, new species.

Plate LXXIV, figs. 2, 2*a*; Plate LXXV, figs. 1, 1*a–c*, 2, 2*a–c*, 3, 4; Plate LXXVI, figs. 1, 1*a–c*, 2.

General contour of body elliptical with nearly equally rounded anterior and posterior extremities. Ventral surface flattened; dorsal surface well arched; ventro-lateral margin as well rounded as permitted by relatively immense papillæ. Mouth and anus ventral, the former

encircled by 17 short tentacles with circular small flat crowns; the latter by a number of small pedicels. Ventrolateral ambulacra with 2 series of large robust pedicels, those of outer series two to three times as large as those of inner, which are rather irregularly arranged along a zigzag line; inner series with about 17 also, not counting the small pedicels surrounding anus. Median ventral ambulacrum with a small pedicel at interior third of body, one at posterior third, another a little nearer than midway between the last and anus, and three or four much smaller ones in front of the anus, three of which seem to form part of the group of anal pedicels. Above outer row of pedicels is a series, more or less irregular, of long flank papillæ (nonretractile), their walls strengthened by long slender spicules. The longer papillæ are 18 to 22 mm. in length and about 1.5 to 2 mm. thick at base. The larger alternate sometimes with shorter slender ones; in all there are 23 to one side and 28 or 29 to the other. With two or three exceptions all papillæ shown in fig. 2, Plate LXXIV, belong to flank series. Dorsal papillæ in an irregular double row along each ambulacrum; of about same length as laterals, but slenderer; 17 or 18 to outer row, about 30 to inner. Deposits: In papillæ, long slender rods with expanded spatulate tips; in pedicels slightly curved rods with short branches near tip; in ventral perisome, robust smooth rods forked at either end and notched, or twice to three times dichotomously branched, the tip with a few circular perforations; in dorsal perisome, smooth rods similar to those of papillæ, but averaging shorter and with tips frequently slightly forked, together with large dichotomously branched rods similar to but larger than those of the ventral perisome, and occasional rods branched only at one end; small spiny and branched rods in wall of gonad. Calcareous ring consisting of both radial and interradial pieces. Color translucent whitish, the pedicels tipped with orange; papillæ with a glassy appearance. Length, 45 mm.; breadth, about 16 mm.

Locality.—Station 3979, vicinity of Bird Island, 222 to 387 fathoms, fine white sand, foraminifera, rocks, bottom temperature 54°; one specimen.

Type—Cat. No. 21219, U.S.N.M.

The lateral or outermost series of pedicels is obviously irregular, but in the posterior region is considerably foreshortened. The inner series is not quite so regular, as may be seen from the figure. Outer pedicels average about 5 mm. in length, the inner 2 to 3 mm.; both are rigid, owing to rods in the walls. Pedicels of median ambulacrum considerably slenderer. Three pedicels very obviously belong to the series, since they are arranged along the line of the median ventral muscle band which shows through the body wall. Of the pedicels surrounding the anus some belong to the median and some to the lateral ambulacra. They are much shorter than any others. Walls of tentacles are strengthened by rods. Crowns do not appear to be

obviously subdivided into lobes. The body when viewed from below presents a lateral bristling fringe of the long, stiff, and remarkable papillæ, whose walls are exceedingly brittle from crowded, long, glassy spicules easily seen with the naked eye, as in fact are the rods of the larger pedicels. These papillæ when perfect are longest at about the middle of the body and decrease in length, forward and backward. They taper gradually but not evenly from a stout base to a rather finely-pointed extremity. The distal portion of the perfect papillæ has an inconspicuous lateral flange of tissue free from spicules, the latter being crowded into a very slender core at one side. In the posterior half of body a very few of the papillæ are a little slenderer than alternate ones, but there is no regularity in this. Near anterior extremity of body three or four smaller papillæ (*a*, *b*, *c*, fig. 2, Plate LXXIV) form a rudimentary second row of lateral papillæ. They stand just above the larger laterals and appear distinct from dorsals. At posterior extremity, as well as at anterior, the papillæ are rather crowded and many of the dorsal are matted down, forming an almost inextricable mass. Only the true lateral or flank papillæ are shown in the figure. Of these there appear to be more on the left side (right of figure), as indicated in diagnosis. The integument of ventral surface is rather thin, but rigid on account of the numerous rods which can just be discerned with the naked eye. With a moderately strong glass they can be clearly seen. A dorsal view of the animal presents a matted mass of long, slender, brittle papillæ. The bases of lateral papillæ extend well onto dorsal surface by reason of the fact that the dorsoventral diameter of base is much greater than the horizontal, being about 4 mm. The dorsum slopes off gradually onto the upper surface of the papillæ. Along either dorsal ambulacrum are about two irregular series of long papillæ similar in character to the laterals. The outer of the two series contains about seventeen or eighteen slender papillæ, about one-third or one-half the diameter of the larger laterals and 20 mm. in length. The spicules appear to be congregated along one side of each papillæ, the rest of wall being transparent. Papillæ of inner series are much more numerous (about thirty), are very irregularly arranged, and are considerably slenderer than the outer series, but appear to be of the same length. Owing to the fact that these papillæ are matted together very intricately it is difficult to make out with absolute accuracy their arrangement. Some papillæ of outer series have three of inner series opposite them, others only one or two. The essential feature is that the inner row of each ambulacrum contains more than twice as many papillæ as the outer and is very irregular in arrangement. The greater part of the dorsal surface is occupied by the flaring bases of the papillæ. The integument is somewhat translucent, the spicules being visible to the naked eye.

Calcareous ring very flexible and delicate, the radial and interradial pieces being joined apparently in one continuous piece; at all events, the line of demarkation is invisible. Form of ring is shown by figure. (Plate LXXIV, fig. 2*a*.) Anterior edge of pieces is so thin that it appears scarcely more than a translucent deposit of lime in the membrane; but the core of both radial and interradial pieces is thicker and is indicated by the lightly shaded portions of figure. Madreporic canal is of considerable thickness, running forward in dorsal mesentary and entering the body wall on level with calcareous ring. One rather large Polian vesicle. Ring canal and adjacent portions of radial canals conspicuous. Gonad forms two tufts on either side of dorsal mesentery, just behind ring canal, the genital duct running forward beneath madreporic canal. Walls of gonad contain comparatively few irregular thorny or slightly branched rods. Longitudinal muscle bands thin and weak.

Ventral perisome contains smooth robust rods dichotomously branched at extremities and with one to several perforations at the tips. The majority have the simpler form shown in figures, but many are thrice branched. The simpler forms usually have no terminal perforations. These rods vary from 0.4 to 0.57 mm. in length. Comparatively few are slightly longer. The figures were drawn from deposits along midventral line. Dorsal perisome is rendered rigid by long, stout, smooth, simple rods with the tips expanded and perforated; or the tips may be divided and each division slightly expanded and perforated. Fewer rods are branched at one end only, the branches being fairly long. Besides these there are comparatively few rods of robust form once or twice dichotomously branched, similar to but very much larger than some of the ventral deposits. These are usually symmetrical at either end and the tips are expanded and several times perforated. The simple rods are much the more numerous and measure about 0.95 to 1.3 mm. in length; some are as short as 0.8 mm. Rods branched at one end only are about 1.6 mm. long; those branched dichotomously vary from 0.9 to 1.3 mm. Rods in lateral and dorsal papillæ are of the same form but differ in size, those of the former being slenderer. The rods are simple, expanded at the tip into a spoon-shaped blade, many times perforated. Rods at base of lateral papillæ are remarkable as to size, many measuring 3.5 mm. in length. (Plate LXXV, fig. 1*d*.) At about middle they measure 1.6 mm. and gradually diminish in length and caliber toward extremity, where they are about 0.65 to 0.95 mm. long, and very slender (fig. 1*c*). In dorsal papillæ a few of the basal rods attain a length of 3.2 mm. They are practically identical with those of lateral papillæ. Rods in pedicels are curved and branched slightly at tips, occasionally with a perforation or two. The longest measure about 1 mm., the shortest about 0.2 mm. Rods in walls of gonad are irregular, about 0.2 to 0.4 mm. in length, with scattered prominent thorns and occasionally one or two short branches.

With the exception of one of the rods of wall of gonad all the accompanying figures represent the deposits enlarged sixty-five times. This affords an easy method of comparison for deposits from different parts of the body. Thus it is seen at a glance that the rods of the dorsal perisome are very much larger than those of the ventral, etc.

This remarkable species differs from *Scotodeima setigerum* Ludwig in the greater development of the papillæ, in the diversity in the number of dorsal papillæ of inner and outer series, in the form and greater size of the deposits, particularly those of the ventral and dorsal perisome, in the number of tentacles, and in the form of the calcareous ring, the latter being composed of radial and interradial pieces. The radial piece is pierced by a hole. If the figures of deposits of *vitreum* are compared with those of *setigerum*[a] (the magnification being taken into account), the difference in size is at once apparent, especially in the rods of dorsal perisome and of papillæ. The rods of the pedicels also present important points of difference, best appreciated by a comparison of figures. Possibly the difference in the calcareous ring is most important, the interradial pieces being absent in *setigerum*. *S. vitreum* differs from *S. protectum* Sluiter[b] in the outer form, number of tentacles, form of calcareous ring, and in the shape of the deposits. It must be remembered that the commonest form of rod in the dorsal perisome of *S. vitreum* is the simple unbranched one. In both the other species the four-armed kind appear to be the only ones, and are considerably smaller than in *vitreum*. On the whole *vitreum* appears more nearly related to *protectum*, which was taken by the Siboga expedition in latitude 0° 34′ 6″ north, longitude 119° 8′ 5″ east, 1,301 meters. *S. setigerum* was dredged by the fisheries steamer *Albatross* at Station 3362, east of Cocos Island, 1,175 fathoms.

Genus ORPHNURGUS Théel.

Orphnurgus Théel, Preliminary Report on the Holothuridæ of H. M. S. Challenger, Œfv. Ak. Forh., Bihang V, No. 19, 1879, p. 8; Challenger Holothurioidea, Pt. 1, 1882, p. 82. Type, *O. asper* Théel.

Tentacles 15 to 20, rather large, nonretractile. Lateral ambulacra of ventral surface with very large pedicels disposed in a single row all along each side of that surface, and with another series of slender, flexible processes placed above pedicels all along each side of body. Odd ambulacrum naked. Dorsal surface with a more or less crowded series of numerous long papillæ disposed in one or two rows along each dorsal ambulacrum. Integument with deposits in the form of smooth or spiny rods sometimes dichotomously branched, or rods transformed into solid large ellipsoids.

[a] Ludwig, Mem. Mus. Comp. Zool., XVII, No. 3, Oct. 1894, p. 72, pl. VII, figs. 7–13; pl. VIII, fig. 1–4.

[b] Siboga Holothurioidea, 1901, pl. II, fig. 7; pl. IX, fig. 4.

ORPHNURGUS INSIGNIS, new species.

Plate LXXIII, fig. 1; Plate LXXVII, figs. 1, 1*a–e*, 2, 2*a–c*, 3, 3*a–e*.

In general form resembling *Orphnurgus asper* Théel, but with dorsal papillæ arranged in a single series along each ambulacrum. Body subcylindrical, slightly broader anteriorly than posteriorly; ventral surface flattened, dorsal well rounded. Mouth terminal, but turned ventralward, large; anus terminal, large, somewhat dorsal. Tentacles, 17 to 20, rather long, nonretractile, with peltoid, divided crowns; ventral tentacles apparently shorter than laterals. Along margin of ventral surface 17 to 22, very large, slightly tapering, cylindrical pedicels with rounded tips, decreasing in length at posterior extremity. Just above these a row of 12 to 18 long, rather slender, tapering papillæ. Along each dorsal ambulacrum a single series of 12 to 36 long papillæ, usually unequal in size and somewhat smaller than the laterals; the longest, longer than width of body (in some specimens papillæ are comparatively short). Integument rather thin in fully expanded specimens, that of ventral surface roughened by the deposits, particularly near posterior extremity. Deposits: In dorsal perisome nearly straight smooth rods of widely varying thickness expanded slightly at tips, bearing several short branches once or twice dichotomously divided, the larger rods usually having a single perforation at either end (Plate XII, fig. 1, 1*a*, *b*, *c*); also four-armed rods dichotomously divided at tips, and rods intermediate between this and first variety (Plate XII, fig. 1*d*, *e*); in ventral perisome very much thicker and heavier rods, dumb-bell shaped with longer and shorter spines which are bifid to multifid at tips, scattered over the subspherical terminal portions; also very many smaller rods with a few or no spines at blunt tips. (Plate XII, fig. 2, 2*a*, *c*.) On posterior third of body these dumb-bell shaped deposits are gradually transformed into irregular ellipsoids spiny along one side and much larger and heavier than other deposits. Ellipsoids are of various sizes and are very crowded. (Plate XII, fig. 3, 3*a*, 3*c*.) In pedicels, stout, simple, or triradiate rods more or less spiny at tips (3*b*, *b'*, *d*, *e*); in papillæ simple slender rods once or twice divided at tips (1 *c*). Color in life, yellowish salmon-color, pinker on body and yellower on pedicels and papillæ. Toward tips of pedicels are small spots of yellowish brown. Tentacles yellow at tips. Length of largest specimen, about 160 mm. in contracted state.

Localities.—Type (Cat. No. 21220, U.S.N.M.) from Station 4134, vicinity of Kauai Island, 324 to 225 fathoms, fine coral sand, volcanic sand; bottom temperature, 43.3°; 5 specimens. Taken also at following stations, in all 118 specimens:

List of stations.

Station.	Locality.	Depth.	Nature of bottom.
3836	South coast Molokai Island	238–255	Brownish gray mud, sand.
3839	....do	259–266	Light brown mud, sand.
3883	Pailolo Channel between Maui and Molokai islands.	277–284	Globigerina ooze.
3979	Vicinity of Bird Island	222–387	Fine white sand, foraminifera rocks.
3988	Vicinity of Kauai Island	469–165	Gray foraminiferous sand, pebbles.
3994	....do	330–382	Fine gray sand, foraminifera.
3997	....do	418–429	Fine gray sand, brown mud.
4015	....do	362–318	Gray sand, rocks.
4021	....do	286–399	Coral sand, foraminifera.
4025	....do	275–368	Fine gray sand, broken shells, foraminifera.
4041	West coast of Hawaii Island	382–253	Gray mud, foraminifera.
4083	North coast Maui Island	238–253	Gray sand.
4084	....do	253–267	Fine gray sand.
4085	....do	267–283	Sand, shells.
4086	....do	283–308	Do.
4096	Northeast approach to Pailolo Channel	272–286	Fine gray sand.
4123	Southwest coast of Oahu Island	352–357	Fine gray sand and mud.
4140	Vicinity of Kauai Island	339–437	Fine gray sand.
3475	South coast of Oahu Island	351	Fine white sand.

The general form of body varies, of course, with degree of contraction. In well expanded specimens dorsal surface is rather high and the lateral interambulacra are rather rounded. In a natural state the specimen shown in fig. 1, Plate LXXIII would be considerably longer.

The large pedicels appear to be pretty constantly 17 to a side for medium-sized individuals and 19 to 22 for the larger ones. In preserved specimens they are unequal in length, the longest being 33 mm. in type. Those near anterior extremity are longer than the more posteriorly situated ones. Lateral papillæ in type are longer than pedicels, 17 and 18 in number, to two sides respectively (pedicels 20). In many small specimens they are quite short and rather distantly spaced, the difference being not altogether due to contraction. Smaller specimens with 17 pedicels have 11 to 17 lateral papillæ. Number and size of dorsal papillæ is also variable, ranging from 12 (to one ambulacrum) in a 90 mm. individual to 36 in a 120 mm. specimen. In most of the small and medium sized individuals they are very much less numerous and conspicuous than in the figured (type) specimen. Some of this difference is due to contraction. In the type the papillæ are fully expanded and the anterior and posteriormost are longest of any. In all but two of the specimens the papillæ appear to be arranged in a fairly regular linear series along each of the two dorsal radii. The exceptions are two small specimens noted in a separate paragraph below. Normal number of tentacles appears to be 20, although they may be as few as 17. The walls are strengthened by spiny tipped rods. (Plate LXXVII, figs. 1*b*, 2*c*, 3*b'*, 3*d*.) Crown is oblique, subpeltate, with about ten branched divisions ending in small subglobular papillæ. The two distalmost branches are much the

largest, the others being graduated toward proximal edge of crown. Théel's figure[a] shows a contracted imperfect specimen.

Polian vesicle single, about 15 to 25 mm. long in medium sized specimens, slender. Madreporic canal rather conspicuous, lodged in dorsal mesentery, and running forward to enter body wall immediately between the two anteriormost, long dorsal papillæ. There appears to be no enlarged madreporic body such as Théel describes for *asper*. Ring canal and proximal portions of radial canals prominent. Calcareous ring rudimentary, consisting of slight deposits of lime in the tissue. Gonad composed of two small tufts on either side of dorsal mesentery immediately behind ring canal. Tubules short, simple, clavate. Genital duct runs forward just above madreporic canal, opening to the exterior by either one or two small papillæ usually situated just posterior to the two large dorsal tentacles. Longitudinal muscle bands *double*, rather slender. Ampullæ of pedicels and papillæ have the cæcal appendage in body cavity short, usually unbranched, except in largest individuals.

One of the commonest forms of spicules of dorsal perisome is that shown by fig. 1, Plate LXXVII, which ranges from 0.55 to 0.8 mm. in length. The number of branches varies, some having fewer, others more than shown in figure. Size of perforations also is variable. Rods of other shapes (*a*, *b*, *c*) are essentially like the first, only slenderer. Average lengths for *a*, *b*, and *c* are 0.6, 0.5, and 0.4 mm., respectively. They vary considerably in length. The four-armed rods, recalling those of *Scotoplana setigerum*, are numerous, and range from 0.35 to 0.5 mm. in length. More or less perfect triradiate forms with equal arms are common, as well as forms intermediate with straight rods (*c*) about 0.6 mm. long. In the region of the lateral tentacles forms intermediate between figs. 1 and 2, 1*a* and 2*a*, 1*c* and 2*b*, *c*, *e*, may be found, or either the one or the other, this being the region of transition between the dorsal and ventral surfaces. The ventral perisome is characterized by much heavier and more crowded deposits, especially toward the posterior end, where the relatively very large ellipsoids and dumb-bell rods are massed together as thick as possible, forming sometimes more than a single layer. Characteristic forms of rods are shown by figs. 2 to 2*e*, these gradually passing into such predominating forms as 3, 3*a*, 3*c*, in posterior third of ventral surface. Sometimes the latter forms predominate over the whole ventral surface, the slenderer rods taking second place. These ellipsoïds are highly characteristic of this species, and commonly attain a size of 0.9 by 0.6 mm., varying down to 0.3 mm. in length. The largest are irregularly spiny along one side and the surface is irregular. The proportion of ellipsoids varies in different individuals; usually various sizes of 3*a*, 2*b*, and 2*d* and intermediate forms predominate,

[a] Challenger Holothurioidea, Pt. 1, pl. XLIV, fig. 3.

with intermediate stages between 2 and 3*a*. The small ellipsoids and rods are very numerous, many as small as 0.18 mm. in length (2*e*). In a single individual all stages between fig. 1 of the dorsal surface and 3 of the ventral are present, the series being 1–2–3*a*–3. Since the deposits are so variable in minute detail, the figures give a far better conception than description can give. In the papillæ the rods are practically identical with 1*b* and 1*a*, and vary in length from 0.2 to 0.6 mm. In pedicels such forms as 3*b*, 3*b'*, 3*d*, 3*e* predominate, 3*b'* being at tip and about 0.2 mm. in length.

Variations.—There are two specimens out of the one hundred and twenty-three odd examples of this species, which, if seen without the others, might lead to some curious conclusions concerning the genus. One is from Station 4041, the other from 3836, both hauls containing also typical specimens. That from 3836 has about thirty pedicels along each ventro-lateral radius, disposed *in two irregular series*, somewhat as in *Scotodeima*. The inner pedicels, which are the smaller, usually alternate with the outer, forming with them a sharply zig-zag series. Scattered along mid-ventral radius are ten smaller pedicels, five of them being in anterior third of body. Along each dorsal ambulacrum about thirty papillæ *in a double row*. The specimen being rather small (50 mm.), there is something peculiar in the deposits. Those of dorsal surface are rather shorter and stouter than in typical form, being of the *a*, *b*, *c*, *d*, shapes (fig. 1); and in addition are many very short stout rods (0.18 mm.) unsymmetrically branched at either end. Deposits of ventral perisome are of 2*b*, 2*d*, 2*e*, 3*e*, 3*d* types, with few spines. In addition are a few very small simple rods (2*e*) 0.05 to 0.08 mm. long, possibly larger rods in course of development.

The second specimen (Station 4041) is 72 mm. long and has twenty-six very small pedicels along the mid-ventral line (recalling *Pannychia*) forming a double row for about two-thirds the length of body. There are about twenty-four pedicels along either side of ventral surface in a single row. The numerous dorsal papillæ form a double row along each ambulacrum. Deposits of dorsal perisome are slender, of the *a*, *b*, *c*, *d* types (fig. 1). Those of ventral perisome consist of stout and slender rods, the former modifications of fig. 2, 2*a* types, the latter of the 1*a* type. They range from 0.15 to 0.45 mm. long, and have unusually large robust spines. Of course the presence of a double ventro-lateral series of pedicels and median ventral pedicels is quite abnormal for this genus. Although the deposits are not typical they seem to belong in with those of the other specimens. The presence of a double row of dorsal papillæ recalls *O. asper* Théel, but the pedicels and madreporic canal, as well as deposits, are different. There seems to be no other course than to regard these specimens as very aberrent examples of *O. insignis*.

This species differs from *O. asper* in the form and size of the

deposits, and from *O. glaber* (Walsh) in having one instead of two rows of papillæ along each dorsal ambulacrum. In respect to deposits *insignis* resembles *glaber* more than *asper*. Kœhler and Vaney have very adequately described and figured *O. glaber*. The deposits of this species lack the large ellipsoids and the more elaborate cruciform rods. *O. invalidus* Kœhler and Vaney has 15 tentacles, has simple rods much like those of *Scotodeima*, and a double row of papillæ along each dorsal radius. In respect to the deposits the species, as noted by the describers, approaches *Scotodeima*.

Genus LÆTMOGONE Théel.

Lætmogone Théel, Preliminary Report on the Holothuridæ of H. M. S. Challenger, Œfv. Ak. Förth., Bihang., V, No. 19, 1879, pp. 9–10; Challenger Holothurioidea, Pt. 1, 1882, p. 73. Type, *L. wyville-thomsoni* Théel.

Tentacles 15 to 20, rather large, not retractile. Lateral ambulacra of ventral surface with large or medium-sized pedicels disposed in a simple series all along each side of that surface. Odd ambulacrum naked. Dorsal surface with long or short flexible processes or papillæ disposed in a single or double series all along each of the ambulacra. Perisome with numerous wheels and with rods and sometimes cruciform bodies.

LÆTMOGONE BISERIALIS, new species.

Plate LXXV, figs. 5, 5*a*; Plate LXXVIII, figs. 1, 1*a–e*.

Body rather elongate, four and one-half to five times as long as broad, tapering slightly at posterior end, which is bluntly rounded; anterior extremity rounded. Ventral surface flattened, dorsal well arched. Mouth terminal but ventral; anus terminal. Tentacles imperfect, but apparently not more than 15; crowns peltate. Pedicels slender, 8 to 10 mm. long at middle of body, numerous, about fifty to a side, forming a single series along each ventro-lateral radius. Midventral radius naked. Papillæ rather short (3 to 5 mm.), forming two series along each dorsal ambulacrum, about sixty-four papillæ to each radius. Deposits: In ventral perisome, small wheels with twelve short spokes and four rather large holes in the nave, two of the holes being larger than the other pair, together with simple rods smooth or uneven along sides and somewhat spiny and irregularly roughened at tips. In dorsal perisome large and small wheels, the former particularly about base of papillæ. Large wheels with usually twelve spokes, and a large nave with six equal perforations. Papillæ with crowded small wheels, a rudimentary terminal plate, and a few rods near tip. Pedicels with much less crowded, small wheels, and many slightly curved supporting rods, sparsely spiny on either terminal third; large perforated terminal plate present. Color of formalin specimen grayish violet. Length, about 90 mm.; width, about 20 mm.

Localities.—Type (Cat. No. 21221, U.S.N.M.) from Station 4141, vicinity of Kauai Island, 437 to 632 fathoms, volcanic sand, foraminifera; bottom temperature, 41 . Station 3988, vicinity of Kauai, 469 to 165 fathoms, gray foraminiferous sand, pebbles.

All but six of the tentacles have been rubbed off, so that it is impossible to give the exact number, which appears, however, to be in the neighborhood of fifteen. This species is especially characterized by the numerous pedicels which form a crowded series along either ventro-lateral radius. These pedicels are much slenderer than those of *Lætmogone wyville-thomsoni*, or of any other figured species, and are not spaced, the bases touching. They are largest in anterior two-thirds of body and decrease slightly in length toward the posterior extremity. Each pedicel has a flat, sole-like sucking disk about 1 to 1.5 mm. in diameter. Breadth of ventral surface between the two series of pedicels is 16 mm. Papillæ are decidedly small for genus, and their arrangement in two series on each dorsal radius is unusual for this group.

Calcareous ring is not divided into separate pieces, but forms a continuous ring as in *L. wyville-thomsoni*. It is thicker and heavier than in that species, and the radial portions present deep cup-shaped depressions on the anterior face. Polian vesicle single, 13 mm. long. Madreporic canal relatively shorter than in *wyville thomsoni* (about 5 mm.), passing upward and backward to open near the middorsal line 18 mm. from anterior extremity of body. The canal on piercing the body wall divides into seven, or probably even more, minute canals, but inasmuch as the external perisome has been completely rubbed off it is impossible to tell whether each of these tubules ends in a papilla as in *wyville-thomsoni*. Gonad forms a large tuft on right and left sides of mesentery; tubules branched. The gonoduct opens to the exterior right beside the madreporic canal, but the papilla has been rubbed off. No spicules in walls of gonad or of alimentary canal.

The wheels of ventral perisome are rather scattered and are more numerous than the rods. Diameter varies from 0.054 to 0.065 mm., the wheels being thus all small and not greatly different in size. Generally there are twelve spokes, but occasionally thirteen or fourteen. The rim is on a different plane from center; in other words, the wheel is shaped like a shallow saucer, the edge being nearest surface of perisome. The large nave is quite constantly pierced by four holes, one pair being always larger than the other. The rods separating these holes form a convexity similar to that of the larger wheels (Plate XIII, fig. 1*a*). Rods vary in length from 0.12 to 0.3 mm.; their form is shown by figures. Owing to the fact that the outer perisome has been scraped off the back, except on the papillæ and on their immediate vicinity, it is not possible to give relative abundance of large and small wheels between the rows of papillæ. Papillæ are crowded with small

wheels (Plate LXXVIII, fig. 1*c*), the majority of which are from 0.04 to 0.068 mm. in diameter. The spokes are so short that, as in the ventral wheels, the interspaces appear sometimes as mere perforations. These wheels are essentially exactly like those of ventral perisome. The large wheels (fig. 1) vary from 0.148 to 0.27 mm. in diameter, and there are relatively few, intermediate in size with the small ones. The spokes are short and the large nave is centrally pierced by six symmetrical holes, forming a nave within a nave. A side view (fig. 1*a*) will give an idea of the form of the wheels. Nearly always there are twelve spokes. Wheels of pedicels are like those of ventral perisome, but rods are larger (fig. 1*c*), commonly attaining a length of 0.45 to 0.55 mm., and are thornier; thorns, however, are all short. There appear to be no X-shaped rods, and there are no rods in dorsal perisome, so far as discoverable. Walls of tentacles are strengthened by rods and the crown is crowded with them. Here they are of greatly diverse sizes and are never straight.

This species agrees with *L. enisus* Sluiter in having two rows of papillæ on each dorsal radius, but the papillæ are short, not long as in *enisus*, which further has 20 large pedicels to each ventrolateral radius instead of 50 or more small ones. In respect to the pedicels *biserialis* approaches *L. théli* Ludwig. That form, however, has but one row of eight to ten spaced papillæ to each dorsal radius, not 64 in two series. Further, it may be added that the deposits of *biserialis* differ from those of the above two species, which are the only ones with which the Hawaiian form is directly comparable.

LÆTMOGONE, species.

There is a small specimen from Station 4043 (west coast of Hawaii, 236 to 233 fathoms, gray sand, broken shells, rocks), which has unfortunately lost all the calcareous deposits. It is therefore futile to attempt an accurate identification. Body rather long and slender; mouth subventral, anus injured, probably terminal. Tentacles 11, large, with circular crowns not greatly wider than the thick stalks. Pedicels long and rather slender, upward of 60 in a zigzag series along each ventrolateral radius; especially irregular on posterior portion of body. Papillæ contracted, shorter than pedicels, about 20 to 25 in a single series along each dorsal ambulacrum. Body wall thin. Color in life: Body translucent grayish or whitish, base of papillæ violet, tube feet transparent.

Of course the number of tentacles is very small. This, taken with the large number of pedicels and single row of dorsal papillæ, separates the former from both *enisus* and *théli* (20 tentacles). There seems little doubt that the specimen is new.

Genus PANNYCHIA Théel.

Pannychia THÉEL, Challenger Holothurioidea, Pt. 1, 1882, p. 88. Type, *P. moseleyi* Théel.

Tentacles 20, rather large and nonretractile. Lateral ambulacra of ventral surface with large pedicels, disposed in a single row all along each side of that surface. Odd ambulacrum with a double row of pedicels. Dorsal surface with a crowded series of numerous scattered slender processes all along each side. Integument with numerous wheels and small wheel-shaped plates.

PANNYCHIA PALLIDA, new species.

Plate LXXVIII, figs. 2, 2*a–h*.

Nearly related to *P. moseleyi* Théel, which it resembles in general form and in the character of calcareous deposits, but it differs greatly in coloration, in having the median ventral series of pedicles much reduced in number, and in the presence of a well-defined calcareous ring. Number of tentacles unknown, but in form closely resembling those of *P. moseleyi*. Anus terminal, mouth turned ventralwards. Pedicels of ventrolateral radii unequal, not particularly large, about 20 or less to each radius. Pedicels of median ventral radius smaller, also unequal, apparently absent from anterior third or fourth of body, about twelve to sixteen in number, and unevenly scattered, the majority being in hinder half of body; not so arranged as to suggest a double row as in *moseleyi*, but rather a very irregular zigzag or meandering series. Papillæ large and small, about 90 on either side of middorsal line, the longest about 15 mm., the shortest about 2 mm. Arranged much as in *moseleyi* with an irregular flank series of short papillæ and about two irregular series of dorsals on either side. The latter are not so regular as in *moseleyi* and encroach upon middorsal region. Body wall of medium thickness. Deposits similar to those of *moseleyi* except in minor details; large wheels with usually fourteen spokes and the crown in center of nave with five or six radii. Color in life, translucent grayish with a yellowish tinge, especially on ambulacral appendages; soles of pedicels abruptly Indian red. Length, 105 mm.; breadth, 15 mm.

Localities.—Type (Cat. No. 21222, U.S.N.M.) from Station 4041, west coast of Hawaii Island, 253 to 382 fathoms, gray mud, foraminifera, bottom temperature 41.6°. Cotype (deposits) from 3994, vicinity of Kauai Island, 330 to 382 fathoms, fine gray sand, foraminifera.

The specimens are not in so good condition as might be desired, inasmuch as the tentacles are scraped off and the body wall badly lacerated. I do not think, however, that there are any more pedicels to the midventral radius than I have indicated. They are very irregularly arranged, especially as to distances between the different ones.

There are but two to four in the anterior half of the body, and as noted above, the anterior fourth of body appears to lack them. About seven or eight of these midventral pedicels are situated within 10 or 16 mm. of anus and are somewhat difficult to separate from the lateral pedicels. This will give an idea of how sparsely they are scattered along rest of odd radius. No fold or collar is apparent on dorsal surface above tentacles. Papillæ are rather long here. Flank papillæ are all rather short. The longest ones are scattered along the innermost series of dorsum.

Calcareous ring is not divided into separate pieces but forms a continuous ring. Radial and interradial portions are clearly discernible, however, the former having three prominent teeth anteriorly, and is pierced by a large hole. The exact form is best shown by fig. 2*g*, Plate LXXVIII. The ring is very delicate and sometimes the lower arms of interradial piece grow across the mouth of the posterior sinus, forming an irregular hole. Just how constant this form is I am unable to say. Madreporic canal opens to exterior by several (at least five) small tubules, just to the right of the genital papilla, which is about 12 mm. from anterior end of body. Canal runs backward and upward from ring canal, and the calcareous particles are much the same as in *P. moseleyi*, possibly a trifle less twisted and interwoven. Polian vesicle 20 mm. long, in left interradius of trivium. Gonad in a right and a left tuft; tubules slender and thread-like, eight to ten times dichotomously divided, extending to posterior extremity of body; not bushy. Longitudinal muscle bands undivided. all five of about equal width.

In general perisome are large wheels very similar to those of *P. moseleyi*, with 10 to 14 spokes, most commonly 14. Their shape is shown better by figures (Plate LXXVIII, fig. 2, 2*a*, 2*c*) than by description. The diameter of these wheels is usually from 0.13 to 0.19 mm. The crown, in center of nave, is made up of five or six arms, as is sometimes the case in typical *moseleyi*. In ventral perisome wheels are spaced, but in the dorsal they are more crowded. Small wheels or wheel-like plates (fig. 2*b*) with three or four central and seven to ten peripheral holes are especially abundant in walls of pedicels, but are common also among large wheels. Their diameter is about 0.046 to 0.065 mm. Plates similar to Théel's fig. 8, Plate XXXII[a] are found at tip of papillæ, and more or less deformed small wheels (fig. 2*d*) in addition, but no spicules like his fig. 9 are discoverable. No plates like his fig. 7 were found, but as the dorsal processes of available material have been under the influence of weak acid the plates are largely imperfect. The disks of the pedicels are strengthened by numerous perforated plates with wider and fewer meshes than Théel's fig. 11. There is but one layer of these plates, and in the smaller

[a] Challenges Holothurioidea, Pt. 1, 1882.

pedicels the central ones have commonly only a few holes and numerous peripheral diverging simple or branched processes. I can find no modified wheel plates similar to Théel's fig. 12. Around the edge of the disk of pedicels are a very few branched three or four armed rods, probably growth stages of the plates. In the oral disk are numerous rods similar to those herewith figured, about 0.12 to 0.165 mm. in length (fig. 2*h*). Besides these are many small wheel-like plates, sometimes irregular or imperfect (fig. 2*e*). In the end of the tentacles are many long, curved, irregular spiny rods (2*f*) which frequently have the ends forked. They vary much in size, but most of them are large, commonly attaining a length of 0.8 or 0.95 mm. Théel figures rods from tentacles, but does not give dimensions. Presumably his fig. 10 is drawn to scale, which would make the rods comparatively small. The difference in these rods is the most striking that is discoverable between the deposits of the two species.

Both *P. moseleyi* and Ludwig's variety *henrici* are of a very decided violet or rose violet tint, but *pallida* is practically colorless, except for a faint yellowish shade to the translucent body wall and the disks of the tube feet, which are abruptly Indian red. (The color was observed in the fresh animal by the writer.) This, combined with the feeble development of the midventral series of pedicels, the perfectly definite calcareous ring which is herewith figured, and some minor differences in the calcareous deposits, especially in the presence of long rods in the crown of the tentacles, seem to constitute specific differences. *Pallida* is undoubtedly nearly related to *moseleyi*, and only future explorations in other localities will decide whether the above differences are constant. *P. multiradiata* Sluiter has wheels with fifteen to eighteen spokes. *P. moseleyi* was taken by the *Challenger* off Sydney in 950 fathoms and off New Zealand in 700 fathoms, both from gray ooze.

Family CUCUMARIIDÆ Ludwig.

Cucumariidæ Ludwig, Mem. Mus. Comp. Zool., Harvard College, XVII, no. 3, 1894, pp. 7, 122.

Subfamily CUCUMARIINÆ R. Perrier.

Cucumariinæ Perrier, Holothuries, Exped. du Travailleur et du Talisman, 1893, p. 492.

Genus THYONIDIUM Düben and Koren.

Thyonidium Düben and Koren, Kongl. Vet. Akad. Handlingar, 1844, p. 214. Type, *Th. commune* Düben and Koren = *Th. drummondi* (Thompson).

According to Théel:

Tentacles 20, exceptionally fewer or more, five pairs of larger alternating with five pairs of smaller. Ambulacral appendages in the shape of pedicels sometimes densely crowded, sometimes more thinly scattered; often an arrangement of them in rows distinguishable along the ambulacra.

KEY TO HAWAIIAN SPECIES OF THYONIDIUM.

a Pedicels scattered all over body; no tables in pedicels.....*hawaiiense.*
aa Pedicels in double rows along ambulacra of trivium, absent from ventral interambulacra; pedicels crowded with modified tables.....*alexandri.*

THYONIDIUM HAWAIIENSE, new species.

Plate LXXIX, figs. 2, 2*a–e.*

Size small; general form subglobose, tapering very slightly toward either end, and abruptly narrowed at the neck; no conical caudal portion; contour of body very broadly elliptical; if neck and tentacles were eliminated, animal would resemble a large papillose gooseberry. Tentacles, five pairs of large, alternating with five pairs of very much smaller ones; only six large tentacles remaining, two pairs apparently having been scraped off. Pedicels numerous and scattered, but slightly more numerous on trivium and there arranged in irregular rows, especially at either end of body; the median line of either ventral interambulacrum nearly free from pedicels, thus forming an inconspicuous narrow naked band. Perisome minutely roughened by spires of tables. Deposits: Tables with a rather symmetrical, subcircular smooth disk pierced by four larger and four smaller alternating perforations; spire composed of two rods, a crossbeam at bottom and near summit, the crown ending in two or four teeth, sometimes irregular with three. At base of tentacles disks of tables elliptical, with four larger central holes and many (fifty or more) smaller perforations, the spire often solid or nearly so, ending in two or three teeth. No tables in pedicels, the latter having well-developed terminal plates. Color in alcohol, violet gray, the pedicels and tentacles brownish. Length, 21 mm.; width, 12 mm.

Locality.—Station 4101, Pailolo Channel between Maui and Molokai islands, 143 to 122 fathoms, coral sand, shells, foraminifera; bottom temperature, 59.7°; 1 specimen.

Type.—Cat. No. 21223, U.S.N.M.

The smaller tentacles are inconspicuous, being only about 1.25 mm. long, while the larger are about 4 to 4.5 mm. The former correspond to the radii, the latter to the interradii. Perisome is moderately thin and rather translucent, though not markedly so. Calcareous ring is very large compared with size of animal, being about 13 mm. long. Radial pieces have posterior prolongations which are rigidly fused with posterior portion of interradial pieces, both being composed of numerous smaller polygonal component plates. Anterior portion of radial pieces fairly solid; figure will show form of pieces. One small madreporic canal and one Polian vesicle. Respiratory trees rather small. Tubules of gonad once or twice dichotomously branched and containing well-developed eggs.

Nearly all the tables of general perisome have the disk similar to fig. 2*a*, Plate LXXIX. This varies in diameter from 0.075 to 0.095 mm. — not a great range. Usually one diameter is slightly greater than the other. The spire, which commonly has an irregular crown, ends in two to four teeth, and is about 0.06 mm. high. Tables are not at all crowded in perisome, but are well spaced. End plates of pedicels are circular and have a diameter of 0.135 mm. The numerous perforations decrease slightly in size toward periphery. The modified tables near base of tentacles have a major diameter of 0.1 to 0.12 mm. The spires vary considerably in height, but seldom exceed those of regular tables. Comparatively few of the latter appear to lack a spire entirely. In perisome between mouth and base of tentacles are numerous rods much branched and forming rosettes, or the branches join, forming irregular perforated plates. They are very irregular in outline and vary from 0.027 to 0.07 mm. in length (Plate LXXIX, fig. 2*e*). The tentacles themselves are devoid of deposits.

This species may be ranged, in Théel's classification,[a] along with *cebuense*, *magnum*, *parvum*, *occidentale*, and *caudatum*, which have deposits of body wall itself, tables, and "calcareous ring of ten simple or compound pieces, always with five radial posterior bifurcate prolongations, made up of several separate parts or joints." The present species differs from each of the above in details of calcareous ring, deposits, as well as in color. *Parvum* has but 18 tentacles. The disk of the tables of *hawaiiense* resemble somewhat those of *Thyonidium inflatum* (Sluiter), but the latter have four upright pieces to spire, and the animal itself, which is figured by Sluiter,[b] has a considerably different habit. On the whole, the present species appears very distinct from any previously described.

THYONIDIUM ALEXANDRI, new species.

Plate LXXIX, fig. 3; Plate LXXX, figs. 3, 3*a–e*.

Tentacles 20, five pairs of large ones, alternating with five pairs of extremely small ones. Body terete, tapering toward either extremity, the posterior being much slenderer than anterior and narrowed into a short caudal prolongation; anterior extremity (tentacles entirely retracted) truncate. Pedicels in a double series along each ambulacrum of trivium, the two ventral interambulacra being entirely naked; pedicels scattered all over dorsal and dorsolateral surface, there being no regular arrangement on two dorsal radii; pedicels larger than in preceding species. Body wall thick and minutely roughened with the densely crowded tables. General facies remarkably like *Cucumaria*. Deposits: Tables similar to those of preceding species, but crown

[a] Challenger Holothurioidea, II, p. 146.
[b] Siboga Holothurioidea, pl. II, fig. 10.

usually ending in about four teeth to each rod; many tables having symmetrical disks with numerous perforations; in pedicels numerous modified tables with elongate, curved, rod-like disk broadened in center with four perforations and with either extremity narrowed, spatulate, and perforated with numerous small holes; spire much as in normal tables; tables, unlike those of preceding species, very densely crowded. At base of tentacles are a few rods with expanded, much perforated extremities, these becoming oblong, oval, subcircular, or regular perforated plates in perisome surrounding base of tentacles, many with and many without spires, and grading into normal tables in neck. Color in alcohol whitish, tube feet yellowish. Length, 20 mm.; greatest breadth, 6 mm.

Locality.—Station 4044, west coast of Hawaii Island; 233 to 198 fathoms, fine gray sand, bottom temperatue 47°; 1 specimen.

Type.—Cat. No. 21224 U.S.N.M.

The larger tentacles are 4.5 mm. long, the smaller about 1 mm. Of course in life these dimensions would be somewhat greater. The body wall is considerably wrinkled, so that it is probable that the animal is considerably contracted. The entire absence of pedicels on the two ventral interambulacra and the fairly regular arrangement along the three radii of trivium, especially the midventral, gives to the species the general appearance of *Cucumaria*. The tentacles, however, are typical of *Thyonidium*. The calcareous ring is large (8 mm. long) and the radial pieces have long posterior prolongations which are composed of many irregular plates. These prolongations of adjacent radial pieces are fused for a part of their length, the interradial pieces being small and wedged in between anterior portions of radials. For exact form see Plate LXXII, fig. 3. One madreporic canal and one Polian vesicle. Gonad very large; tubules unusually short, thick, and branched once or twice.

The tables with regular disks have a major diameter of about 0.086 to 0.1 mm. (Plate LXXX, fig. 3*a*), this type being very similar to the normal tables of the preceding species. The larger irregular disks attain 0.012 mm. (3*b*). Spires are about 0.057 mm. high, the two uprights being joined by a crossbeam near summit and each ending in about four to six teeth. Occasionally the upper crossbeam is absent. Figures 3*c* and 3*d* show the type of table which crowds the pedicels. Many are less regular than this, being curved in the plane of the disk as well as in that of the spire. End plates of pedicels have a diameter of about 0.24 mm.; perforations numerous, rather larger about periphery than in center.

This species differs from *hawaiiense* in the following respects: Shape of body, thickness of perisome, color, distribution of pedicels and their larger size, presence in pedicels of modified tables, very crowded condition of deposits, character of tables, presence of a few rods in

base of tentacles, form of calcareous ring. *Alexandri* belongs to the same section of the genus as the preceding species and is very distinct from any known form. The distribution of pedicels is unusual for this genus. The specimen is evidently adult, because the gonad is very large.

This species is named for Mr. A. B. Alexander, of the Bureau of Fisheries, fisheries expert during the Hawaiian cruise. To his effective coöperation in that region of difficult dredging much of the success of the undertaking was undoubtedly due.

Subfamily PSOLINÆ R. Perrier.

Psolinæ R. Perrier, Holothuries, Exped. du Travailleur et du Talisman, 1903, pp. 493, 512.

Genus PSOLUS Oken.

Psolus Oken, Lehrbuch der Naturgeschichte, Pt. 3, Zool., 1815, p. 352.

Tentacles, 10; ventral surface flat, with two or three rows of pedicels, the median radius often without them; dorsal surface convex, without ambulacral appendages, usually with large calcareous scales or external plates; mouth and anus sometimes with distinct valvular plates; edge of body sharp.

PSOLUS MACROLEPIS, new species.

Plate LXXIX, figs. 1, 1*a–f*.

Tentacles 10, rather small, arborescent. Body broadly oval, much depressed. Dorsal scales not numerous, but large, only slightly imbricating, the edges, however, very tightly fitted together; lateral scales decreasingly smaller, those surrounding rim rather minute; only two rows of scales between mouth and anus, the middorsal region being occupied by about four scales larger than the rest. Mouth surrounded by five regular triangular valves, the sides of which are subequal, and the bases defining a rude circle; a small triangular scale between adjacent oral valves at their base; this is absent between two scales. Anal aperture surrounded by about twelve scales, five of which are shorter and broader than others (see figure). Surface of all scales except minute ones about rim of body beset with irregularly spaced, small granules, which are rather sparse on mouth and mediodorsal scales, and nearly lacking on anal. Sole flat; median ambulacrum wholly without pedicels; the lateral ambulacra with two series of pedicels, of which the outer are smaller, rather more numerous and situated close to sharp edge of body. Deposits: In ventral perisome perforated plates of irregular shape, either smooth or provided with a few knobs, the perforations from four to twenty in number; in pedicels a terminal plate and numerous elongated, perforated, mostly smooth rod-like plates with undulating.

almost spiny border; in dorsal perisome surrounding base of tentacles, irregular elongated plates with many perforations; in tentacles comparatively very large irregular, curved perforated rods (or sometimes without perforations and spiny or branched); in finer branches of tentacles smaller, very variable rather finely perforated plates. Sole thin and translucent. Color in life: Ground color, very dull light brown, the center of each scale being a darker brown; five oral plates, a pinkish yellow ocher, light carmine at tips, the anal opening salmon pink. Length, slightly curved, 19 mm.; breadth, 16.5 mm.; width of circle of oral valves, 7.5 mm.; distance from edge of oral valves to edge of anal, 6 mm.; from center of oral aperture to center of anal, 11 mm.

Locality. Station 3863, Pailolo Channel between Maui and Molokai islands, 127 to 154 fathoms, broken coral, coarse gravel, rocks; bottom temperature, 60°. One specimen on a lump of lava.

Type.—Cat. No. 21225, U.S.N.M.

Owing to the fact that the specimen is a trifle bent to conform to the surface of the rock on which it was found, the breadth in the figure is too great in proportion to actual length. The outlines of the scales near margin are very inconspicuous, the plates themselves being very tightly fitted together, although imbricating slightly, as do also the middorsal plates. In addition to the granules the surface of scales is regularly and microscopically roughened, giving under a magnifying glass the appearance of tesselation. The series bordering sharp edge of body is very small and free from granules. When the oral valves are viewed from inner surface a rather narrow oblong scale or plate is seen to be fitted over the radial suture between two oral valves, there being thus five of these secondary oral scales. Their distal tips are pointed, and from the exterior can be indistinctly seen between the tips of the primary oral scales. On the inner surface at tip of each secondary or inner oral valve is a small, pointed deciduous tooth-like ossicle, the five points meeting in center of oral aperture. These can not be seen from exterior at all.

The plates in the sole are well spaced and the largest attain a major diameter of 0.24 mm., although the majority are about 0.135 to 0.15 mm. The central perforations are usually the largest. Edge of plates is undulating or marked by blunt lobes. Knobs are present on most of larger plates, such as fig. 1*b*, but plates of the type of fig. 1*c* (length 0.1 mm.) do not have them as a rule. At edge of sole the plates become considerably larger (0.24 mm.) with relatively smaller holes and more prominent undulations on margin. The plates consequently appear stouter and heavier. They grade into the elongated rod-like perforated plates of pedicles which attain a maximum length of 0.28 mm., decreasing in size toward tip of pedicel. The plates in membrane surrounding base of tentacles are especially distinguished from

those in sole by having many comparatively and actually smaller perforations. They vary from oblong to triangular, oval, or irregular, and some are to be classed as rods. These plates are smooth, but comparatively few of the largest which have the central holes conspicuously larger than the rest have a few knobs on the surface. Plates of this type (fig. 1*f*) attain a major diameter of 0.22 mm., though most of them are shorter than this. The large rods in the stem of the tentacles (1*e*) attain a length of 0.5 mm., but many are considerably smaller. They are usually slenderer than fig. 1*e*, with fewer perforations. In the smaller branches of tentacles are smaller, crowded, irregular, perforated plates, similar to but smaller than the perforated plates in perisome surrounding base of tentacles. They are much more irregular in shape.

The presence of large regular oral valves and of the two rows of pedicels on lateral ambulacra allies this form to *Ps. antarcticus* (Philippi), *tuberculosus* Théel, *ephippifer* Wyville Thomson, and *diomedeæ* Ludwig, from all of which it is separated by the very narrow region between mouth and anus, there being but two rows of large plates intervening. The dorsal plates, are relatively larger than in *diomedeæ* and the granules smaller and more numerous. There is also a great difference in the size of oral and anal valves in *macrolepis*, while the anal valves are quite different from those of *diomedeæ*, as may be seen by a comparison of figures.[a] In *macrolepis* the oral valves when closed are flush with the general surface of dorsum, but in *diomedeæ*, judging from the figure, are slightly raised. The deposits also present points of difference, especially in the size of the knobs on the plates these being large and conspicuous in *diomedeæ*. The present species may be readily distinguished from the other relatives above mentioned by the two series of dorsal plates between mouth and anus. *Diomedeæ*, from the vicinity of Cocos Island, appears to be the nearest of kin.

Order PARACTINOPODA Ludwig, 1891.

Family SYNAPTIDÆ Burmeister.

Synaptidæ Burmeister, Handbuch der Naturgeschichte, 2. Abth. Zoologie, 1837.

Subfamily SYNAPTINÆ Östergren.

Synaptinæ Östergren, Öfv. Ak. Förh., 1898, p. 111 (Das System der Synaptiden).

Genus SYNAPTULA Örsted.

Synaptula Örsted, Synaptula vivipara, Vid. Meddel. Nat. Foren. Kjøbenhavn for 1849 ad 1850, 1851, p. 7. Type, *Synaptula vivipara* Örsted.

[a] Mem. Mus. Comp. Zool., XVII, No. 3, 1894, pl. VI, figs. 1, 2, 3.

Leptosynapta (part) VERRILL, Trans. Conn. Acad. Sci., I, Pt. 2, 1867–71, p. 325. Type, *L. tenuis* (Ayres) = *Synapta inhærens* (O. F. Müller); not equivalent to *Synaptula*, but some species referred to *Leptosynapta* now referable to *Synaptula*.

Heterosynapta VERRILL, Trans. Conn. Acad. Sci., I, Pt. 2, 1867–71, p. 346. Type, *Holothuria viridis* Lesueur = *Synaptula vivipara* Örstergren.

Chondroclœa (part) ÖSTERGREN, Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar, 1898, No. 2, p. 113. Type, *Synapta indivisa* Semper.—SLUITER, Siboga Holothurioidea, 1901, p. 125.

Tentacles 10 to 27 pinnate, usually with numerous divisions; retractor muscles present (except in *S. nigra* according to Semper). Cartilaginous ring present between calcareous ring and ring canal; perforations in cartilaginous ring posterior. Anchors with unbranched stock or handle[a] to shaft, flukes smooth, the middle of the arch beset with small granular protuberances. Anchor plates with large central toothed hole surrounded by six other toothed[b] holes, but that nearest handle only partly toothed, or smooth, and its outer end rather acute. This hole is arched over by a curved rod with two (not four) supports—i. e., it is not branched where attached to anchor plates, as in following genus. Madreporic canal single, unbranched.

Synaptula as here used includes the first division of Östergren's *Chondroclœa*; that is, all the species enumerated by him with the exception of *Synapta beselii*.[c] Unfortunately Östergren's appropriate name can not be retained for this group because antedated by *Synaptula* Örsted. Örsted's species (*vivipara*) is a fairly typical member of this genus, so that it is not possible to restrict *Synaptula* to a narrower genus and retain *Chondroclœa*.

The still earlier name *Tiedemannia* Leuckart can not be applied with certainty to any species, although it was given ostensibly to

[a] This handle is finely toothed, but not with conspicuous divisions, as in *Euapta* and *Opheodesoma*.

[b] A difference in the serrations of these holes exists between *Euapta* and *Synaptula*. In the former the teeth occupy the whole circumference of the holes (except in handle) on the side directed toward exterior of body wall (or that on which the bridge occurs in the handle). On the inner side of the plate they occupy only half the circumference. In *Synaptula* the teeth occupy only half (but opposite halves) of the circumference on both surfaces of plate. In *Opheodesoma* the teeth are as in *Euapta*.

[c] The type of *Synapta* Eschscholtz (1829) is *Synapta mamillosa*. This is equivalent to the earlier *Holothuria maculata* Chamisso and Eysenhardt, 1821, according to Dr. Hubert Lyman Clark *in litt.* The name therefore stands *Synapta maculata* (Chamisso and Eysenhardt), with *Synapta mamillosa* Eschscholtz, 1829, *S. oceanica* (Lesson, 1830), *?Synapta radiosa* (Lesson, 1830), *?S. punctulata* (Quoy and Gaimard, 1833), *?S. doreyana* (Quoy and Gaimard, 1833), *S. beselii* Jäger, 1833, and possibly others as synonyms. The name *Synapta* can not be used for the *inhærens* group as Östergren proposed. The genera closely allied to *Synapta* in the order of their description stand as follows:

Synapta ESCHSCHOLTZ, 1829. Type, [*S. mamillosa*] *S. maculata* (Chamisso and Eysenhardt) Clark [=*S. beselii* Jäger, and authors]. Synonyms: *Oncinolabes*

Fistularia vittata Forskål.[a] Leuckart says: "Muss offenbar ein eigen Genus bilden, welches ich Herrn Geheimen Rath Tiedemann zu ehren, der sich so gross verdienste um die Anatomie der Echinodermen erworben hat, *Tiedemannia* genannt habe. L." This is in a footnote. In the text above the following occurs: "Er [Prof. Leuckart] zeigte unter anderen, dass *Fistularia* (*Holothuria*) *vittata* keine Athmungswerkzeuge habe wie *Holothuria tubulosa* u. a., dass der Eierstock aus zwei mehrfach verästelten Schläuchen bestehe." Dr. Östergren writes me as follows concerning *vittata:* "'*Chondroclæa vittata* (Forsk.)' werden Sie in meinem Verzeichnis der Synaptiden nicht finden. Unter der Namen *Synapta vittata* (Forsk.) findet man in der Litteratur *verschiedene Arten* der Gattungen *Chondroclæa* und *Euapta*, von denen jedoch keine mit Forskål's *Fistularia vittata* identisch sein dürfte, denn diese besitzt nur 12 Tentakel (die Angabe Forskal's im Texte wird durch die Figur bestätigt). Mir liegen mehrere solchen Arten aus dem Rothen Meere vor jedoch konnte ich kein von diesen sicher mit der Art Forskål's identificieren."

There can be no certainty, therefore, that Leuckart really had Forskål's species, and indeed that this species is a *Synaptula*, as might be surmised from Théel's summary. If *vittata* has only 12 tentacles, naturally both Théel and Lampert are in error in placing the number at 15. The name *Tiedemannia* consequently can not seriously compete with *Synaptula*. It seems questionable if Forskål's species can ever be accurately identified, since so much confusion already exists in regard to it.

SYNAPTULA KEFERSTEINII (Selenka).

Synapta kefersteinii Selenka, Beiträge zur Anatomie und Systematik der Holothurien, Zeitschr. f. wiss. Zool., XVII, 1867, p. 360, pl. xx, figs. 120, 121. (Sandwich Islands.)—Semper, Holothurien, 1868, p. 14, pl. v, fig. 24; pl. xxxix, fig. 11.—Théel, Challenger Holothurioidea, Pt. 2, 1886, p. 19. Authors up to Östergren.

Brandt, 1835; ?*Reynaudia* Brandt, 1835; *Chondroclæa* (part), Östergren, 1898. This is a monotypic genus differing from *Synaptula* in the character of the anchor plates, and branched madreporic canal.

Synaptula Örsted, 1851. Type, *S. vivipara* Örsted. Synonyms: *Leptosynapta* (part) Verrill, 1867–1871; *Heterosynapta* Verrill, 1867–1871; *Chondroclæa* (part) Östergren, 1898.

Leptosynapta Verrill, 1867–1871. Type, *L. tenuis* Ayres (not Quoy and Gaimard)=*L. inhærens* (O. F. Müller). Synonyms: *Dactylota* (part) Brandt, 1835; *Synapta* Östergren (not Eschscholtz), 1898.

Euapta Östergren, 1898. Type, *Eu. godeffroyi* (Semper).

Labidoplax Östergren, 1898. Type, *L. buskii* (M'Intosh); *Synapta tenera* Norman is a *nomen nudem.*

Protankyra Östergren, 1898. Type, *P. abyssicola* (Théel).

Opheodesoma nob. Type, *O. spectabilis*, new species; see below. Near *Euapta.*

[a] Oken's Isis, XXIII, 1830, p. 685.

Chondroclœa kefersteini ÖSTERGREN, Das system der Synapteden, Öfversigt, etc., 1898, no. 2, p. 114.

Tentacles 25 to 26, with 30 to 62 (or even 80 according to Semper) digits along either side in a crowded zigzag series, or even two series. Cartilaginous ring 7 mm. wide, with 17 small perforations on posterior border. Polian vesicles 23 in the single specimen available. Single madreporic canal in dorsal mesentery; madreporic body rather elongate. Anchor arms smooth, the stock on handle without processes but very minutely roughened along the edge. Anchor plates symmetrical, with six larger dentate holes, a smaller partially dentate one, together with two large and three or four small smooth ones at the handle. Miliary granules, small irregular rods or incomplete rosettes. Color in life, brownish green; in alcohol, reddish brown.

Localities.—Station 4031, Penguin Bank, south coast of Oahu Island, 27 fathoms, fine coral sand, foraminifera, coral; Station 3876, Auau Channel, between Maui and Lanai islands, 28 to 43 fathoms, sand and gravel; 5 fragments.

The specimen from 4031 consists of a fragment about 250 mm. long (in life) of the anterior portion of an animal, while those from 3876 are fragments of the posterior part of two or three smaller individuals. The former has lost the calcareous deposits through dissolution, but in the latter specimens they are in good condition. The deposits agree fairly well with Selenka's figure. In the handle of the anchor plates, which are 0.24 to 0.25 mm. long, are three small smooth holes and two large. The third large hole, which is smooth in Selenka's figure, is toothed around the posterior border. This hole is considerably smaller than the other two in the handle and is median in position. Of the three small holes the median is the largest. The rod which forms an arch across handle is toothed on posterior border and has one or two teeth on outer border. The teeth in the six serrate holes are very conspicuous. The stock or transverse handle at the end of the shaft of the anchor is without any processes, but it is minutely roughened. There are a few granuliform protuberances on the central portion at the base where the two flukes join each other. Miliary granules are similar to Semper's figures, namely, small irregular rods about 0.01 to 0.0135 mm. long, often expanded into plate-like forms. (Plate LXXX, fig. 2.)

Three fragments of a small individual minus the anterior end were also taken at 3876. The deposits are essentially as in the adult, but the handle of the anchor plates may have as many as five or six small holes. The handle or stock is more frequently absent from the anchor shafts, and the miliary granules are simpler than in the above-described specimen, almost exactly like Semper's figures. Ludwig has noted that the seventh hole in the anchor plate is toothed[a] and Bedford[b] in a specimen from Rotuma found toothed and smooth holes.

[a] Zool. Jahrb. Syst., III, 1888, p. 818. [b] Proc. Zool. Soc., 1898, p. 847.

This species, the type of which came from the Hawaiian Islands, may be readily distinguished from other synaptids of the region by the number of tentacles. Semper records the species from Samoa, and it has been taken also at Amboina, Rotuma, and Kosseir (Red Sea).

Genus EUAPTA Östergren.

Euapta Östergren, Das System der Synaptiden, Öfv. Ak. Forh., No. 2, 1898, p. 112. Type, *Euapta* (olim *Synapta*) *godeffroyi* (Semper).—Sluiter, Siboga Holothurioidea, 1901, p. 123.

Synapta (part) Authors up to Östergren.

Tentacles normally 15 (13 to 17) pinnate, with numerous digits either free or united by web for half their length. Cartilaginous ring absent. Stock of anchors branched, arms smooth, but beset in middle of arch (opposite end of shaft) with numerous small granuliform protuberances. Anchor plates with a large central hole, surrounded by six (or seven) other large holes, all toothed,[a] except that adjacent to handle, which is toothed on inner part of circumference only. Handle of plate arched over by a curved rod with four supports, i. e., it joins the plate in two places, on either side. The handle or attached end of anchor plates with two large and several small smooth holes, one of the large holes situated on each side of the rather acute outer end of the usual large median hole of the handle; the latter, as well as the lateral holes of the handle, is spanned by the arched rod. Calcareous ring without conspicuous anterior projections. Madreporic canal single (or very few and dorsally situated). Retractor muscles present.

This is equivalent to section A of Östergren's *Euapta* and includes *godeffroyi* (Semper), *lappa* (J. Müller), and *polii* (Ludwig).

EUAPTA GODEFFROYI (Semper).

Synapta godeffroyi Semper, Reisen ein Archipel Philippinen, Pt. 2, I, Holothurien, 1868, p. 231, pl. xxxix, fig. 13 (Samoan Islands).

Euapta godeffroyi Östergren, Das System der Synaptiden, Öfv. Ak. Forh., No. 2, 1898, p. 113.

Tentacles 14 to 16 (14 and 15 in Hawaiian examples) pinnate, with about 56 to 70 digits united for about half their length by a thin web. Deposits: Anchors with smooth arms and about six to eight minutely spiny processes to handle of shaft; anchor plates with seven large dentate holes and two large and three (or more) small smooth holes in handle; the seventh hole acutely ovate and only partially dentate; miliary rosettes subcircular with a hole in center. Anchors not deformed in Hawaiian specimens. Color in alcohol, creamy white with spaced broad bands of olive brown across the back and slightly darker lines than general body tone along dorsal radii. The ground

[a] A difference in the distribution of the serrations of these holes in *Synaptula* and *Euapta* has been mentioned under *Synaptula*.

color of body is really a livid grayish, closely marbled with creamy white representing aggregations of rosettes. The brown bands more or less spotted with whitish. Tentacles grayish green to yellowish gray. Polian vesicles large, about 30 in number. Madreporic body single, in dorsal mesentery. Length of alcoholic specimen, 250 mm.

Localities.—Station 3872, Auau channel between Maui and Lanai islands, 43 to 32 fathoms, yellow sand, pebbles, coral; Station 3876, same locality, 28 to 43 fathoms, sand and gravel; Hilo, Hawaii (H. W. Henshaw, collector, Acc. No. 41822, U.S.N.M.); 4 specimens.

The calcareous ring is slightly different from the figure given by Semper. Thus the radial pieces have an anterior perforation but the posterior border is not so deeply notched, rather less so than the interradial pieces, which are also a trifle less excavated. The Polian vesicles are somewhat unequal in length, the longest being 30 mm. The long rachis of either half of gonad gives off at intervals a slender tubule three or four times dichotomously branched. Retractors well developed. Madreporic body is elongated.

The anchor plates, the exact form of which is best seen from the figure (Plate LXXXI, fig. 3*c*), appear to be rather more regular than in Samoan examples, judging from Semper's figures. The two larger smooth holes of handle are symmetrically placed, the rather acute anterior end of the odd half-serrate hole being between their hinder ends. Usually there are three small perforations on edge of handle, the central one being largest; rarely, however, there is but one, or the three are subequal and less regular than in figure. Plates are about 0.27 mm. long. I find no peculiar anchors with triradiate shafts such as Semper figures. The arms or flukes are occasionally bent off their plane. The stock or handle to shaft has six to eight minutely spiny or rugose processes, and there are a few granuliform protuberances at the opposite end where the two arms join. Anchors are about 0.38 mm. long. Rosettes are about 0.021 to 0.027 mm. in diameter. In perisome surrounding mouth are many rosettes and numerous straight or slightly curved rods thickened or branched, and minutely spiny at tip. The surface of these rods, which are abundant also in digits of tentacles, is thickly covered all over with minute granuliform spines or asperities. Their length in the tentacles is 0.13 to 0.27 mm. and in the oral disk 0.12 to 0.24 mm., usually nearer the former than latter dimensions. (See Plate LXXXI, fig. 3*b*.) These rods are not mentioned by Semper, but they were probably overlooked in the type specimens. Neither does Bedford speak of them. He found no malformations in the deposits in his specimens from Rotuma.[a]

Euapta godeffroyi has been recorded from Mauritius, Pelew, Thursday, Fiji, Samoa, Caroline, and Rotuma. The Hawaiian records thus materially extend its known range.

[a] Proc. Zool. Soc., 1898, p. 847.

OPHEODESOMA, new genus.

Type.—Opheodesoma spectabilis.

Numerous madreporic canals, distributed around the ring canal. Cartilaginous ring sometimes present, when perforations are along anterior border, not along posterior border as in *Synaptula*. The two large lateral holes in handle of anchor plate absent, the central hole larger than in *Euapta*, and rounded, not acute, on the outer edge; plates otherwise as in *Euapta*. Calcareous ring with conspicuous anterior projections. Tentacles and anchors as in *Euapta*. Retractors present.

Some notes on this genus will be found under the following species. The genus includes species mentioned under section B of Östergren's *Euapta—glabra* (Semper), *grisea* (Semper), and *serpentina* (J. Müller).

OPHEODESOMA SPECTABILIS, new species.

Plate LXVI; Plate LXXX, figs. 1, 1*a–d;* Plate LXXXI, fig. 2.

Tentacles 15 (very rarely 16), rather long, pinnate; digits, 30 to 70 (usually 50 to 54), united for half their length by a web. When living the animal is characterized usually by five regular series of numerous large globular protruberances extending from end to end of body; occasionally these are absent. Body wall rough, opaque. Deposits: Symmetrical anchor plates with six large toothed holes, and in the handle one still larger hole (serrate on border toward free or large end of plate and rounded, not acute on opposite border), and in addition four or five small smooth holes bordering free edge of handle. Occasionally one or two small partially serrate holes are present on distal border of plate, causing some asymmetry. Anchors with smooth flukes, and about seven to ten minutely spinous protuberances on the stock or handle to shaft. Miliary granules, tiny rosettes usually with a small hole in center. Cartilaginous ring well developed, with medium-sized holes on anterior border, adjacent to calcareous ring. Polian vesicles many (over 100); madreporic canals small and very numerous, forming a crowded series over the whole extent of ring canal. Color in life, reddish orange spotted with brown, the brown forming transverse more or less interrupted bands; ventral surface posteriorly grayish, spotted with whitish and barred with dark gray. Tentacles dark dull greenish. The protruberances are usually rather dark. Length variable. The largest individuals observed were 600 mm. long (2 feet). Others were 300 to 450 mm. The length depends largely, of course, on the amount of extension of the animal at moment of measurement.

Locality.—Pearl Harbor, near Honolulu, Oahu (Aiea and other portions of harbor). Very common in shallow water on sandy bottom and on submerged coral; 60 specimens.

Type.—Cat. No. 21226, U.S.N.M.

The tentacles appear to be quite constantly 15 except for two specimens which have 16. They are 20 to 25 mm. long when extended. Occasionally one or more tentacles are considerably smaller than the rest, but as there is no constancy in position, I suppose these represent regenerating members. Occasionally individuals are found which have lost a tentacle and possess an incipient "bud" in its place. As noted in the diagnosis, the number of digits varies considerably, but in the large tentacles it is usually over 50. The small number of 30 is found only on small tentacles above alluded to. If one is fortunate in finding a tentacle with the digits extended, the web is seen to extend slightly beyond the middle of the digits. The longest digits are at the middle of the tentacle, and thence they are graduated in size toward either end, the smallest being proximad, where they cease about 6 mm. from base. The surface of body is very rough with the anchors, but the surface of the perisome itself appears to be smooth in decalcified specimens.

The calcareous ring is fairly stout and is composed of 15 pieces, there being two interradials between each radial. Both are slightly excavated on posterior border. The radials have a large perforation on the anterior border and the interradials a simple subspatulate process. The exact form is best appreciated from figures. The cartilaginous ring is about 5 mm. wide and the perforations occur regularly opposite each piece of the calcareous ring, so that the concave posterior border of the piece forms the anterior edge of a perforation. These perforations vary in size, even in the same individual, being from 0.5 to 1.25 mm. long. In the dorsal mesentery is a single slender madreporic canal, and in addition very many (upward of fifty) shorter ones form a crowded series all along the ring canal. The latter are curved or twisted and are about 0.5 to 1 mm. in length, usually less than a millimeter. Polian vesicles are extremely numerous (125 in one specimen), and in preserved specimens are often slender and filamentous, forming a tangled mass of threads all around the ring canal. At their base is the wreath of madreporic canals. Length of Polian vesicles about 10 mm. or less. Gonad in a right and a left tuft. When fully developed it extends nearly to middle of body. The long slender rachis gives off at intervals a slender tuft of tubules, which is really a single tubule three or four times dichotomously branched. Fairly well developed retractor muscles are present. Ciliated urns are abundant on mesentery near attachment to body wall. This portion of mesentery in anterior part of body is finely perforated.

The anchor plates are fairly broad for length, the latter being 0.285 to 0.298 mm. The exact form is best appreciated from figure. Usually there are six toothed holes, but occasionally one or two small perforations occur at broad end. A plate with one such is figured. (Plate

LXXXI, fig. 2.) Besides the four or five smooth holes on border of handle, several very fine perforations are occasionally interpolated irregularly between these and the edge. The anchors are 0.4 to 0.45 mm. long. On the edge at the point where the flukes join are three or more inconspicuous granuliform protuberances. The flukes are sometimes slightly twisted off their proper plane, and are thus asymmetrical. The small rosettes are subcircular and 0.0135 to 0.0189 mm. in diameter. They are more numerous on the lighter portions of the integument (especially ventrad) than on the darker, and are so arranged as to give the effect of marbling under low power of microscope. When they are particularly abundant they leave more or less open circular spaces (where they are only scattered) in which an anchor and its plate occur. In the perisome surrounding the mouth are numerous rods 0.0675 to 0.135 mm. long, smooth except for the tops, which are slightly swollen and bluntly toothed or merely roughened (Plate LXXX, fig. 1*d*). No rods in digits as in *Euapta godeffroyi*, but relatively few rosettes occur there.

This strikingly colored synaptid is abundant in the shallow water of Pearl Harbor, at Aiea, and other localities. From the shore one may see numerous individuals slowly crawling over the soft bottom among the scattered sea weeds. Many specimens were taken with a dip net from the boat landing at Doctor McGrew's place, Aiea. When the animal is moving the tentacles are slowly brought into play. The large globular excrescences, which frequently form five series along the body, may possibly aid in locomotion, although numerous individuals without these were observed creeping about. It will be noted that these protuberances do not form double rows as in *Synapta maculata* [i. e., *beselii*] and *Opheodesoma glabra*.

This species is closely related to *Opheodesoma glabra* (Semper). I have sent specimens to Dr. H. L. Clark, who believes that they are referable to *glabra*, as he is inclined to minimize the importance of the cartilaginous ring. After a thorough reexamination, I am unable to agree with Doctor Clark and have decided to keep the form separate, although in a different genus from that in which I originally placed it (*Synaptula*). Thus, following Doctor Clark, I have considered the form of the calcareous particles as of generic value, rather than the presence of a cartilaginous ring.

The following characters in parallel columns will serve to contrast *spectabilis* and *glabra*. The authorities for the statements concerning *glabra* are in parentheses. Neither Doctor Clark nor I have seen specimens of this species.

Spectabilis.	*Glabra.*
Well-developed cartilaginous ring present.	Cartilaginous ring absent.[a] (Théel.)
Interradial pieces of calcareous ring broadly truncate anteriorly; radial pieces rounded anteriorly with large hole.	Interradial pieces tapering anteriorly and subacute; radial pieces angular anteriorly with small hole. (Semper, Pl. IV, fig. 8*a*.)
Surface of body very rough from the anchors (both in life and when preserved in alcohol). Anchors lie near surface.	Surface of body smooth, not roughened by anchors either in life or when preserved. Anchors deep in the skin. (Semper,[b] Sluiter.)
Characteristic protuberances when present forming five single series along body.	Characteristic protuberances when present forming five double series along body. (Semper, Pl. II.)
Color in life, reddish orange spotted with brown, the brown forming transverse more or less interrupted bands; ventral surface grayish posteriorly, spotted with whitish and barred with dark gray.	Color in life, uniform Van Dyke brown; in alcohol, uniform reddish brown or dark brown. (Semper, Pl. II, Théel.)

[a] Théel states (Challenger Holothurioidea, Pt. 2, p. 20): "Cartilaginous ring absent." Semper does not mention the ring in his original description (Holothurien, p. 12), but as he mentions its presence in all the species of *Synaptula* he described we are led to suppose that the structure is absent in *glabra*. Furthermore, Sluiter, who has described numerous species of *Synaptula* (sub nomine *Chondroclæa*), places *glabra* under *Euapta*, which he would not have done without remark if a cartilaginous ring had been present. Östergren, who gives primary importance to the cartilaginous ring, did not find it in *glabra*.

[b] This I consider an important difference. Semper says (Holothurien, p. 11, under *Synapta beselii*): "Bei einer 3 Fuss langen neuen Art, meiner *Synapta glabra*, liegen diese Organe [i. e., the anchors] im Gehen so tief in die Haut eingebettet, dass ich sie wegen ihrer ganz glatten schlüpfrigen Haut für ganz ankerlos hielt, solange ich die Haut nicht microskopisch untersucht hatte." Under the description of *glabra* (p. 12) he says: "Hier liegen die Anker * * * so tief in der Haut, dass man sie erst nach dem Tode leicht erkennt, denn selbst unsanfte Berührung veranlasst das lebenskräftige Thier nicht im Mindesten sie hervorzustrecken, sodass ich langer Zeit das Thier für eine riesige Chirodota hielt."

I handled over a hundred *Opheodesoma spectabilis* in life and can safely affirm that the anchors are in nowise embedded deep in the skin. They are in evidence as soon as one picks up an animal.

There is no *Synaptula* with which the present species can be confused, on account of the fundamental difference in the form of anchor stock and the presence of numerous madreporic bodies in combination with 15 tentacles. Several species have been listed as *Synapta vittata*, these species being either *Synaptula* or *Euapta*. The *Synapta* or *Fistularia vittata* of Forskål is unknown. Théel lists a 15-tentacled "*Synapta vittata*," which has a cartilaginous ring (according to Müller, although Müller probably did not know a *Fistularia vittata*.) Under

his synonymy Théel gives a reference to Herapath.[a] This figure is that of some *Euapta*. Lampert[b] lists *Synapta vittata*, with the same reference to Herapath in synonymy. He, however, examined a specimen at first hand, for he found "*numerous madreporic bodies*." No known species occurs which has madreporic bodies numerous (*Opheodesoma*) and at the same time anchors and plates like those figured by Herpath (*Euapta*). Just as Doctor Östergren says, in his letter, different authors are trying to fasten Forskål's name on to several different species of at least two genera. Sluiter has recently[c] listed a specimen of "*Chondroclava vittata*," basing his identification on Jäger's description,[d] but there is no telling what his 13 tentacled species is. He gives no figures.

Thus it would seem that all the comparisons of *Opheodesoma spectabilis* must be made within the genus and not with Synaptulas; *Opheodesoma glabra* is the only species which shows very close resemblances with *spectabilis*.

Perhaps the erection of a new genus requires some defense. The character of the anchor plates, the numerous madreporic canals, the occasional presence of a cartilaginous ring differing in structure from that of *Synaptula*, the presence of anterior projections on calcareous ring divides the group of *spectabilis*, *glabra*, *grisea*, and *serpentina* very sharply from that of *godeffroyi* and *lappa*. In respect to the cartilaginous ring, *spectabilis* bridges the gap to *Synaptula*, but the differences in deposits are sharp, while the ring itself is different in structure.

Genus PROTANKYRA Östergren.

Synapta (part) AUTHORS up to Östergren.

Protankyra ÖSTERGREN, Öfv. Ak. Forh., LV, 1898, p. 116. Type, *Synapta abyssicola* Théel.

Tentacles 10 to 14 digitate with four or five digits. Retractor muscles and cartilaginous ring absent. Anchor arms serrate, the vertex without minute knobs or granules; stock or handle branched occasionally. Anchor plates without abruptly narrowed handle and with numerous irregular holes. Almost always an irregular perforated arch over the attached end of plate, united with latter in several places. Circumference of plate uneven or incomplete.

[a] Quarterly Jour. Mic. Sci., 1865, pl. 1, fig. 6, is exact reference, according to Lampert.

[b] Seewalzen, p. 216.

[c] Siboga Holothurioidea, p. 126.

[d] De Holothuriis, 1833, p. 14.

PROTANKYRA ALBATROSSI, new species.

Plate LXXXI, figs. 1, 1*a*; Plate LXXXII, figs. 4, 4*a–c*.

Tentacles 12 (varying occasionally to 13 or 14), with 4 digits, the 2 terminal being longest, a series of three to six small "sensory cups" on either side of tentacle between proximal digit and base. Two ventral Polian vesicles. Madreporic canal, single, dorsal. Deposits: Anchors with a rather long shaft, spiny handle and upward to nine teeth on either arm. Anchor plates rather large, very variable, with two large central holes and numerous smaller ones; edge uneven; occasionally an incipient handle. Along the radii, in oral disk, and tentacles, many irregular rod-shaped, C-shaped, O-shaped, and variously formed grains. Color in life, translucent white, often with a pale lilac tinge. Length of large specimen, 100 mm., slender.

Localities.—Type (Cat. No. 21227, U.S.N.M.) from Station 3840, south coast of Molokai Island, 266 to 314 fathoms, light-brown mud, sand, rocks; bottom temperature, 46°. Taken also at the following stations:

List of Stations.

Station.	Locality.	Depth.	Nature of bottom.
3835	South coast of Molokai Island	169–182	Fine brown sand, mud.
3836	do	238–255	Brownish gray mud, sand.
3839	do	259–266	Light-brown mud, sand.
3895	do	252–429	Coral, rocks.
3984	Vicinity of Kauai Island	237–164	Fine coral sand.
3998	do	235–228	Coarse brown coral sand, shells, rocks.
4043	West coast of Hawaii Island	236–233	Gray sand, broken shells, rocks.
4044	do	233–198	Fine gray sand.
4079	North coast of Maui Island	143–178	Gray sand, foraminifera.
4082	do	220–238	Gray sand.
4083	do	238–253	Do.
4132	Vicinity of Kauai Island	257–312	Fine gray sand, mud.
4139	do	512–339	Fine gray sand, rocks.
4140	do	339–437	Fine gray sand.
4141	do	437–632	Volcanic sand, foraminifera.
4142	do	632–881	Coarse manganese sand rocks.

Ninety specimens.

Tentacles are usually 12, but specimens with 13 and 14 are occasionally found, often from the same station as those with 12. The digits are fairly constantly 4; only in a single case out of a number examined did a tentacle have 5. Along either side of the tentacle between the proximal digit and the base is a series of from three to six small pear-shaped bodies attached by the smaller end, about 0.2 to 0.25 mm. in length. They apparently correspond to the "ciliated sucking disks" which Semper figures for *Anapta gracilis*. In the present specimens they appear to be considerably contracted, and it is not certain whether there are cilia present at the tip. The series is not always very regular, the proximal body standing out of line in many cases.

The anchor plates are very variable in shape, and many are in different stages of development. Complete plates range from 0.2 to

0.27 mm. in length. There are two large central holes, but the others vary so much in size that it is futile to attempt a detailed description. The figures will serve to illustrate the usual type. Occasionally there is an incipient handle (Plate LXXXII, fig. 4), such as is well developed in *Labidoplax*, but plates in the same individual vary greatly in this respect. In specimens from a more considerable depth (4141, 4142) the outline of the plates is rather more even, the two central holes are relatively smaller than those from lesser depths, the calcareous framework is somewhat stouter, and the plates average a little larger. The anchors are 0.24 to 0.35 mm. long. Many are represented by simple rods, being in a state of development. The miliary grains vary considerably in number, being scarce in some specimens and abundant in others. When present in normal numbers they are arranged in two series along each radius, with others scattered sparsely on either side of the series. The O- and C-shaped grains are commonest, but other forms are numerous. In some specimens variations of straight or slightly curved rods predominate. In the shaft of the tentacle, C- and O-shaped bodies predominate, but in the digits slightly curved rods. Grains in the body range from about 0.04 to 0.065 mm. in length; those in the tentacles are smaller, and those in oral disk smallest. The figures are drawn to scale.

Although this species is undoubtedly closely related to *Protankyra challengeri* (Théel), there are a number of differences of considerable importance, namely, the presence of two series of little "sensory cups" on tentacles, the variable number of tentacles, arrangement of miliary granules, as well as their somewhat different form, more elaborate anchor plates. Even the calcareous ring presents points of difference.[a] Sluiter[b] has named a variety *sibogæ*[c] of *P. challengeri*, the plates of which are more like those of the present species than are typical *challengeri*. In other points *sibogæ* seems to be very close to *challengeri*, which was taken in 140 fathoms at Fiji Islands.

It may eventually be found that *challengeri* is a very wide ranging and variable species, including possibly apparently separate forms, but it is pure assumption to so regard it at present. It seems far better, in view of the differences pointed out above, to regard the Hawaiian specimens as belonging to a separate species, which may well bear the name of the fisheries steamer *Albatross*.

[a] Compare Plate LXXXII, fig. 4*a*, with Plate I, fig. 4*d*, Challenger Holothurioidea.

[b] Siboga Holothurioidea, p. 131.

[c] This is an unfortunate name, since it invalidates the *sibogæ* given on the following page (132) to a different species of *Protankyra*. Since *P. sibogæ* is now without a name, it may be called *Protankyra sluiteri*, after its discoverer.

Genus ANAPTA Semper.

Anapta Semper, Reisen im Archipel Philippinen, Pt. 2, I, Holothurien, 1868, p. 17. Type, *Anapta gracilis* Semper.

Tentacles 12, pinnate. Deposits in form of oval or elongate grains, or entirely absent. General form, synaptoid.

ANAPTA INERMIS, new species.

Plate LXXIII, fig. 2; Plate LXXXII, fig. 1.

Tentacles 12, digitate, each with about 12 to 16 very small, slender digits; end of tentacles rounded without an evident odd terminal digit. Digits increase slightly in size distad. General form of body rather robust, with rounded posterior extremity. Body wall thin, translucent, the five longitudinal muscle bands showing plainly. Deposits entirely wanting. Color in alcohol, bleached grayish, profusely covered with small reddish brown or yellowish brown spots, more abundant in anterior than in posterior part of body. In type these spots are fused on anterior half of body, giving a raw sienna tint with larger grayish spots and smaller dark brown dots. Often the brownish mud in alimentary canal gives the body a brown hue. In some specimens the small brown spots are few in posterior portion of body. Calcareous ring stout, composed of ten and eleven pieces in two specimens dissected. Pieces unequal, both radial and interradial with an anterior tooth and nearly straight posterior border. One large Polian vesicle. (Plate LXXXII, fig. 1.) One very short, rather inconspicuous, madreporic canal at anterior edge of dorsal mesentery. Gonad large, with a central trunk to either tuft, from which spring branches either simple or once dichotomously branched. Alimentary canal very large and usually gorged with mud, giving the animal a plump appearance. Length, about 100 mm.; greatest breadth, about 14 to 20 mm.; in life probably somewhat longer and slenderer.

Localities.—Type (Cat. No. 21228, U.S.N.M.) from Station 3910, south coast of Oahu Island, 311 to 337 fathoms, fine gray sand and mud; bottom temperature 43.7 ; 2 specimens. Taken also from the following stations, in all, 11 specimens.

List of stations.

Station.	Locality.	Depth.	Nature of bottom.
3839	South coast Molokai Island	259–266	Light brown mud, sand.
3916	South coast Oahu Island	299–330	Gray sand, mud.
3919	....do	294–257	White sand, mud.
3997	Vicinity of Kauai Island	418–429	Fine gray sand, brown mud.
4088	North coast Maui Island	306–297	Fine gray sand.
4089	....do	297–304	Do.

On account of the absence of deposits in the skin it is rather difficult to assign trenchant characters to this species. Consequently a figure of the external appearance is given. The pieces of the calcareous ring are a trifle variable and the dorsal radial pieces are likely to be a little irregular, as shown in figure. There is constantly but one large Polian vesicle. The shaft of the tentacles is very large and stout in comparison with the small digits which are slightly irregular in length. In life the disparity may not be present.

The absence of deposits is certainly not due to acid, since a *Sigmodota* in perfect condition, so far as deposits are concerned, was taken from the bottle in which specimens were kept for over two years. The only known species with which the present form might be confused is *Anapta subtilis* Sluiter from the Bay of Batavia. *Inermis* differs in having 12 to 16 instead of 4 or 5 digits to tentacles, and in having a stout calcareous ring instead of a rudimentary one; no papillæ on body in *inermis;* one instead of several Polian vesicles. *Inermis* is also longer in proportion to width than *subtilis*. *Subtilis*, like *inermis*, lacks calcareous deposits.

Subfamily CHIRIDOTINÆ Östergren.

Chiridotinæ Östergren, Öfv. Ak. Förh., 1898, p. 117.

Genus CHIRIDOTA Eschscholtz.

Chiridota Eschscholtz, Zoologischer Atlas, Pt. 2, 1829, p. 12. Type, *Chiridota discolor*, Eschscholtz.

Tentacles 10 to 20, peltate, digitate. Deposits: Groups of wheels inclosed within walls of the integument, and, in addition, often more or less curved rods. Wheels with six spokes. Hermaphrodite.

KEY TO HAWAIIAN SPECIES OF CHIRIDOTA.

a. Wheel papillæ numerous, in five longitudinal series on body ..... *hawaiiensis*.
aa. Wheel papillæ few (8 to 50) in a single dorsal series ..... *uniserialis*.

CHIRIDOTA HAWAIIENSIS, new species.

Plate LXXXI, fig. 5; Plate LXXXII, figs. 3, 3*a–c*.

Near *Chiridota rigida* Semper. Tentacles 12; digits 8 to 10, the two terminals being conspicuously larger than laterals, which are graduated in size, the smallest being proximad. Ventral interambulacra with a single rather irregular series of "wheel papillæ," at least in proximal half of body; when present beyond middle, very few and scattered. Three dorsal interambulacra with many more numerous wheel papillæ, which are much more crowded in anterior than poste-

rior half of body. Anteriorly they are scattered, often encroaching upon radii; posteriorly they form a very irregular zigzag series; sometimes very few posteriorly. Papillæ unequal in size. Deposits: Wheels and numerous scattered, small, slightly curved, and C-shaped rods, swollen or knobbed at the tips, together with straight rods forked at one or both ends. In tentacles are numerous larger, more elaborately branched rods. In addition numerous small oval grains, or grains swollen at both ends and constricted in middle, are found in longitudinal muscles. Body wall thin, translucent. Color in life, between burnt carmine and pomegranate purple, translucent. Wheel papillæ light yellowish red. Length, 15 to 45 mm.; breadth, 2 to 7 mm.; usually broadest posteriorly.

Locality.—Reef between Honolulu Harbor and Waikiki, Oahu, in tide pools. The animals live a few inches beneath the surface of the soft, sandy bottom of numerous tide pools and are very common. About 125 specimens.

Type.—Cat. No. 21230, U.S.N.M.

In general form the body is cylindrical, often, but not always, broader posteriorly than anteriorly. Posterior extremity rounded to truncate, depending upon the degree of contraction. Tentacles are about 2.5 mm. long and the two terminal digits about 0.5 to 0.57 mm. The number of digits is constantly 8 to 10, the same individual having tentacles with 8, 9, or 10 digits. In the case of 9 digits there are two enlarged terminal ones, just the same as when an even number is present. The number of tentacles is very rarely 13. In a large number counted only one individual was found which thus departed from the normal number. As noted in the diagnosis, there is a single series of spaced wheel papillæ on each of the two ventral interambulacra, but in posterior half of body these papillæ are very few or are wanting. There are rather more papillæ on middorsal interambulacrum than on the two dorso-laterals, although the difference is not great. In some individuals a rather irregular series is formed along the three interradii, but generally the papillæ are scattered so that no regular serial arrangement is discoverable within each interambulacrum. The wheel areas under the microscope are seen to be circular or elliptical, usually the latter, and range from 0.24 to 0.6 mm. in diameter.

Calcareous ring (Plate LXXXII, fig. 3*f*) does not possess any peculiar characters. Madreporic canal single, in dorsal mesentery. Polian vesicles, 11 or 12, of which 4 are considerably larger than the rest.

The wheels (Plate LXXXII, fig. 3) vary in diameter from 0.045 to 0.1 mm., many sizes being found within a single group, where they are packed several layers deep. The small curved rods vary in length somewhat, the commoner lengths being found between 0.03 and 0.046 mm. The tips and sometimes the middle are slightly swollen, the former being provided with incipient thorns in some cases. The forked

rods are fairly common. All the rods are rather evenly scattered and are found in the tentacles, being there different in shape and more elaborately branched at the tips and subterminally. (Plate LXXXII, figs. 3*b*, *c*.) These rods are also larger, measuring commonly from 0.048 to 0.076 mm.. The grains (fig. 3*a*) are very numerous along the longitudinal muscles and are 0.019 to 0.03 mm. in length.

The species to which *hawaiiensis* shows nearest relationship are *rigida* Semper, *liberata* Sluiter, and *amboinensis* Ludwig. From *rigida* the species differs in having constantly 8 to 10 digits to the tentacles instead of 13; in having less numerous wheel papillæ, especially on the ventral interambulacra; in possessing much heavier spokes to the wheels, and probably also in the presence of numerous oval and dumbbell grains along longitudinal muscles. The calcareous ring is nearly identical with that of *liberata*. From *liberata*, *hawaiiensis* differs in distribution of papillæ, in the presence of branched rods in integument, in the greater number of Polian vesicles. *Amboinensis* is very close to *rigida*, according to Ludwig's short description, and differs from *hawaiiensis* in the same respects as *rigida*. It is not possible to tell from any of the descriptions of the above forms whether the much branched rods in the tentacles of *hawaiiensis* are peculiar. If they are, they will afford an additional character of importance.

These little animals were found by the writer in digging for Enteropneusta, *Ptychodera laysanica* Spengel being rather common in the same habitat. The broad, flat reef which extends from Honolulu Harbor toward Waikiki is uncovered by the receding tide for a considerable width. Many little pools are left in the coral, and it is in the sandy bottoms of these that *Chiridota hawaiiensis* is so common a few inches beneath the surface of the sand. The alimentary canal is always gorged with coral sand. *C. liberata* Sluiter lives on live or dead coral over which it creeps.

CHIRIDOTA UNISERIALIS, new species.

Plate LXXX, fig. 4; Plate LXXX, figs. 5, 5*a*–*c*.

Tentacles 12; digits 10 to 12, the 2 terminal larger than the rest, the subterminal nearly as large, and the rest graduated in size, the proximal digits being very small. Middorsal interambulacrum only with "wheel papillæ," which are scattered very irregularly in a single lineal series the whole length of body, or are confined mostly to posterior half. Papillæ are of conspicuous size and 9 to 50 in number. Surface of body, as in preceding species, is slightly roughened by small, low, flattish, wart-like eminences, which are apparent only when animal is contracted. Deposits: Wheels larger than those of *hawaiiensis*, and smooth straight or curved rods slightly swollen at middle and with two or three blunt incipient spines at tips. In muscle bands are

smooth rods with rounded tips. Color in life, two phases, one dark purple, the other pale lilac; wheel papillæ whitish; tentacles brownish. Length, about 150 mm.; breadth variable, in unconstricted state, 7 to 9 mm.

Locality.—Station 3892, north coast of Molokai Island, 328 to 414 fathoms, fine gray sand; bottom temperature 42.5 ; 10 specimens.

Type.—Cat. No. 21229, U.S.N.M.

The present species is much larger than the foregoing and differs in the great reduction in number of wheel papillæ as well as in color. The wheel papillæ vary greatly in number and apparently are more numerous in the light than in the dark individuals, which have in the neighborhood of ten papillæ, mostly in posterior two-thirds of body. In only one case have I found a papilla outside of the middorsal interambulacrum. In one individual a small papilla is situated just at the upper edge of a dorso-lateral interambulacrum and is nearly radial in position. Inasmuch as the body is constricted at intervals it is not possible to tell the exact breadth. Tentacles are much contracted in preserved specimens. The proximal digits are often so small that it is then difficult to tell whether there are 8 or 10 digits. The prevalent number appears to be 12 or 11. The terminal digits are only slightly larger than the subterminal, although in an uncontracted state the difference may be greater.

The calcareous ring is sufficiently shown by the figure (Plate LXXXII, fig. 5*c*). There are five Polian vesicles, of which two are much larger than the other three. Madreporic canal single, in dorsal mesentery. Tubules of gonad unbranched. Retractor muscles rather stout, confluent with longitudinal bands about 15 mm. from anterior extremity of body.

Wheels from same individual do not differ so much in size as in *hawaiiensis*, and are larger than in that species. They vary from about 0.12 to 0.19 mm., the majority being about 0.175 mm., in diameter. The rods are commonly about 0.08 to 0.12 mm. long, while the smooth ones in the muscles vary from 0.041 to 0.08 mm. Most of the rods of outer perisome have one to three shallow notches at tip, and occasionally a short branch in the center. Somewhat deformed grains such as X, fig. 3*a*, are rarely seen, but real C-shaped rods appear to be absent. The deposits are rather evenly scattered, but appear to be lacking in tentacles.

This species differs from the other 12-tentacled forms in the distribution of the wheel papillæ, of which there are a very small number, confined to middorsal interambulacrum. In respect to the small number of wheels, at least, *uniserialis* resembles *Trochodota purpurea*[a]

[a] Not to be confused with *Sigmodota purpurea* Studer (*Chiridota studeri* Théel), which has S-shaped deposits, and which has been considered as a synonym of *Chiridota contorta* Ludwig, a *Tæniogyrus*.

(Lesson), but differs in having numerous scattered curved or straight rods with swollen notched tips, in addition to the minute smooth rods in muscle bands. *T. purpurea* has, moreover, sigmoid deposits in the external perisome besides the scattered aggregations of wheels. It is found at the Falkland Islands. *C. pisanii*, from the Chonos Archipelago, coast of Chile, 45° south latitude, also resembles *uniserialis*, having C-shaped deposits in the tentacles and one row of wheel papillæ in each of the three dorsal interambulacra. *Pisanii* is nearer *purpurea* than is *uniserialis*.

Genus TÆNIOGYRUS Semper.

Tæniogyrus Semper, Holothurien, 1868, p. 23. Type, *Chirodota australiana* Stimpson.

Tentacles 10 to 12. Deposits, S-shaped rods, and sometimes wheels with six spokes, grouped in papillæ.

Semper's genus *Tæniogyrus*, founded on Stimpson's *Chirodota australiana*, a fairly close relative of Ludwig's *contorta*, is quite distinct from either *Chiridota* or *Trochodota*.

TÆNIOGYRUS, species.

Plate LXXXII, fig. 2.

From Station 3919, south coast of Oahu Island, 257 to 220 fathoms, gray sand, there is a fragment of a *Tæniogyrus* evidently closely related to *T. contorta* (Ludwig). Tentacles 12; digits probably about 11 or 12, but tentacles are too contracted to ascertain accurately. Wheel papillæ are present, but the integument is too much injured to ascertain arrangement. Polian vesicles 10, of unequal size; madreporic canal single. Deposits, wheels, in groups, and very numerous sigmoid rods (Plate LXXXII, fig. 2). The wheels resemble those figured by Théel,[a] and have a diameter of 0.09 to 0.175 mm., while the sigmoid particles are slightly different, as may be seen by comparing figures. The latter are 0.185 to 0.23 mm. long, being thus smaller than in *contorta*.

The color of the specimen is whitish in alcohol, and the length is about 60 mm. The specimen is apparently nearly whole, but has been twisted and rubbed over sand till it resembles a dirty piece of cord. About the only differences which can be determined are in the number of Polian vesicles and size and shape of the sigmoid deposits. The species is evidently close to *contorta*.

[a] Challenger Holothurioidea, Pt. 2, pl. 11, fig. 2*a*.

LIST OF DREDGING STATIONS AND OF SPECIES COLLECTED AT EACH STATION.

Station 3813, south coast Oahu Island. Depth, 264 to 183; bottom, coral sand, lava specks, shells:

Mesothuria murrayi.

Station 3824, south coast Molokai Island. Depth, 222 to 498; bottom, coral rocks, broken shells:

Bathyplotes patagiatus.

Station 3834, south coast Molokai Island. Depth, 8; bottom, coral rocks, sand, shells:

Holothuria impatiens, Holothuria fusco-olivacea.

Station 3835, south coast Molokai Island. Depth, 169 to 182; bottom, fine brown sand, mud:

Protankyra albatrossi.

Station 3836, south coast Molokai Island. Depth, 238 to 255; bottom, brown gray mud, sand:

Orphnurgus insignis, Protankyra albatrossi.

Station 3839, south coast Molokai Island. Depth, 259 to 266; bottom, light brown mud, sand:

Orphnurgus insignis, Protankyra albatrossi.

Station 3840, south coast Molokai Island. Depth, 266 to 314; bottom, light brown mud, sand, rocks:

Protankyra albatrossi.

Station 3847, south coast Molokai Island. Depth, 23 to 24; bottom, sand, stones:

Holothuria paradoxa.

Station 3863, northeast approach to Pailolo Channel, between Molokai and Maui islands. Depth, 127 to 154; bottom, broken coral, coarse gravel, rocks:

Psolus macrolepis.

Station 3866, northeast approach to Pailolo Channel, between Molokai and Maui islands. Depth, 283 to 284; bottom, gray mud, fine sand:

Mesothuria murrayi, Pseudostichopus propinquus.

Station 3872, Auau Channel, between Maui and Lanai islands. Depth, 43 to 32; bottom, yellow sand, pebbles, coral:

Holothuria hawaiiensis, Holuthuria anulifera, Euapta godeffroyi.

Station 3876, Auau Channel, between Maui and Lanai islands. Depth, 28 to 43; bottom, sand, gravel:

Holothuria hawaiiensis, Holothuria anulifera, Synaptula kefersteinii, Euapta godeffroyi.

Station 3883, Pailolo Channel, between Maui and Molokai islands. Depth, 277 to 284; bottom, globigerina ooze:

Mesothuria murrayi, Orphnurgus insignis.

Station 3887, north coast Molokai Island. Depth, 552 to 809; bottom, globigerina mud:

Pelopatides retifer.

Station 3892, north coast Molokai Island. Depth, 328 to 414; bottom, fine gray sand:

Chiridota uniserialis.

Station 3895, south of Molokai and west of Lanai islands. Depth, 252 to 429; bottom, coral rocks:

Protankyra albatrossi, Mesothuria parva.

Station 3910, south coast of Oahu Island. Depth, 311 to 337; bottom, fine gray sand, mud:

Anapta inermis.

Station 3916, south coast Oahu Island. Depth, 299 to 330; bottom, gray sand, mud:
Anapta inermis.

Station 3919, south coast Oahu Island. Depth, 257 to 220; bottom, gray sand:
Mesothuria parva, Anapta inermis, Tæniogyrus, sp.

Station 3979, vicinity of Bird Island. Depth, 222 to 387; bottom, fine white sand, foraminifera, rocks:
Pælopatides rectifer, Scotodeima vitreum, Orphnurgus insignis.

Station 3984, vicinity of Kauai Island. Depth, 237 to 164; bottom, fine coral sand:
Protankyra albatrossi.

Station 3988, vicinity of Kauai Island. Depth, 469 to 165; bottom, gray foraminiferous sand, pebbles:
Mesothuria carnosa, Bathyplotes patagiatus, Orphnurgus insignis, Lætmogone biserialis.

Station 3994, vicinity of Kauai Island. Depth, 330 to 382; bottom, fine gray sand, foraminifera:
Bathyplotes patagiatus, Orphnurgus insignis, Pannychia pallida.

Station 3995, vicinity of Kauai Island. Depth, 427 to 676; bottom, fine gray sand, rocks:
Pælopatides retifer.

Station 3997, vicinity of Kauai Island. Depth, 418 to 429; bottom, fine gray sand, brown mud:
Mesothuria carnosa, Orphnurgus insignis, Anapta inermis.

Station 3998, vicinity of Kauai Island. Depth, 235 to 228; bottom, coarse brown coral sand, shells, rocks:
Mesothuria parva, Protankyra albatrossi.

Station 4015, vicinity of Kauai Island. Depth, 362 to 318; bottom, gray sand, rocks:
Orphnurgus insignis.

Station 4019, vicinity of Kauai Island. Depth, 550 to 409; bottom, gray sand, foraminifera, rocks:
Pælopatides retifer.

Station 4021, vicinity of Kauai Island. Depth, 286 to 399; bottom, coral sand, foraminifera:
Mesothuria carnosa, Bathyplotes patagiatus, Orphnurgus insignis.

Station 4022, vicinity of Kauai Island. Depth, 399 to 374; bottom, coral sand, foraminifera, rocks:
Pælopatides retifer.

Station 4025, vicinity of Kauai Island. Depth, 275 to 368; bottom, fine gray sand, broken shells, foraminifera:
Ophnurgus insignis.

Station 4028, vicinity of Kauai Island. Depth, 444 to 478; bottom, gray sand, globigerina:
Pælopatides retifer.

Station 4031, Penguin Bank, south coast of Oahu Island. Depth, 27 to 28; bottom, fine coral sand, foraminifera, coral:
Synaptula kefersteinii.

Station 4038, west coast of Hawaii Island. Depth, 689 to 670; bottom, gray mud, foraminifera:
Pælopatides retifer.

Station 4039, west coast of Hawaii Island. Depth, 670 to 697; bottom, gray mud, foraminifera:
Pælopatides retifer.

Station 4041, west coast of Hawaii Island. Depth, 382 to 253; bottom, gray mud, foraminifera:
Mesothuria carnosa, Orphnurgus insignis, Bathyplotes patagiatus, Pannychia pallida.

Station 4043, west coast of Hawaii Island. Depth, 236 to 233; bottom, gray sand, broken shells, rocks:

Lætmogone, sp., *Protankyra albatrossi*.

Station 4044, west coast of Hawaii Island. Depth, 233 to 198; bottom, fine gray sand:

Thyonidium alexandri, *Protankyra albatrossi*.

Station 4079, north coast of Maui Island. Depth, 143 to 178; bottom, gray sand, foraminifera:

Protankyra albatrossi.

Station 4081, north coast of Maui Island. Depth, 202 to 220; bottom, gray sand, foraminifera:

Mesothuria parva.

Station 4082, north coast of Maui Island. Depth, 220 to 238; bottom, gray sand:

Protankyra albatrossi.

Station 4083, north coast of Maui Island. Depth, 238 to 253; bottom, gray sand:

Orphnurgus insignis, *Protankyra albatrossi*.

Station 4084, north coast Maui Island. Depth, 253 to 267; bottom, fine gray sand:

Orphnurgus insignis.

Station 4085, north coast Maui Island. Depth, 267 to 283; bottom, sand, shells:

Orphnurgus insignis.

Station 4086, north coast Maui Island. Depth, 283 to 308; bottom, sand, shells:

Orphnurgus insignis.

Station 4088, north coast Maui Island. Depth, 308 to 306; bottom, fine gray sand:

Mesothuria murrayi, *Anapta inermis*.

Station 4089, north coast Maui Island. Depth, 297 to 304; bottom, fine gray sand:

Anapta inermis.

Station 4096, northeast approach of Pailolo Channel. Depth, 272 to 286; bottom, fine gray sand:

Mesothuria murrayi, *Orphnurgus insignis*.

Station 4101, Pailolo Channel, between Maui and Molokai islands. Depth, 143 to 122; bottom, coral sand, shells, foraminifera:

Thyonidium hawaiiense.

Station 4110, Kaiwi Channel, between Molokai and Oahu islands. Depth, 449 to 460; bottom, gray sand:

Pæloparides retifer.

Station 4115, northwest coast of Oahu Island. Depth, 195 to 241; bottom, coral sand, foraminifera:

Mesothuria parva.

Station 4122, southwest coast of Oahu Island. Depth, 192 to 352; bottom, coarse coral, sand, shells:

Mesothuria parva.

Station 4123, southwest coast of Oahu Island. Depth, 352 to 357; bottom, fine gray sand and mud:

Orphnurgus insignis.

Station 4130, vicinity of Kauai Island. Depth, 283 to 309; bottom, fine gray sand:

Mesothuria carnosa.

Station 4131, vicinity of Kauai Island. Depth, 309 to 257; bottom, fine gray sand:

Mesothuria carnosa.

Station 4132, vicinity of Kauai Island. Depth, 257 to 312; bottom, fine gray sand and mud:

Mesothuria carnosa, *Protankyra albatrossi*.

Station 4134, vicinity of Kauai Island. Depth, 324 to 225; bottom, fine coral and volcanic sand:

Mesothuria carnosa, *Bathyplotes patagiatus*, *Orphnurgus insignis*.

Station 4136, vicinity of Kauai Island. Depth, 294 to 352; bottom, fine coral sand:
Mesothuria carnosa.

Station 4139, vicinity of Kauai Island. Depth, 512 to 339; bottom, fine gray sand and rocks:
Mesothuria carnosa, Protankyra albatrossi.

Station 4140, vicinity of Kauai Island. Depth, 339 to 437; bottom, fine gray sand:
Bathyplotes patagiatus, Orphnurgus insignis, Protankyra albatrossi.

Station 4141, vicinity of Kauai Island. Depth, 437 to 632; bottom, volcanic sand, foraminifera:
Pælopatides retifer, Lætmogone biserialis, Protankyra albatrossi.

Station 4142, vicinity of Kauai Island. Depth, 632 to 881; bottom, coarse manganese sand, rocks:
Protankyra albatrossi.

Station 4151, vicinity of Bird Island. Depth, 800 to 313; bottom, fine coral sand, foraminifera, stones:
Pælopatides retifer.

Station 4176, vicinity of Niihau Island. Depth, 672 to 537; bottom, gray sand, mud, foraminifera:
Pælopatides retifer.

Station 4187, vicinity of Kauai Island. Depth, 508 to 703; bottom, gray sand, foraminifera:
Pælopatides retifer.

EXPLANATION OF TECHNICAL TERMS.

The calcareous deposits are likely to cause some trouble to the naturalist unacquainted with holothurian anatomy, because they have been given arbitrary technical names. These names are listed below, together with a number of other technical terms which are not self-explanatory.

ambulacra, the five radii.

anal teeth, calcareous teeth, five in number, surrounding anus of *Actinopyga*.

anchor plates, the perforated, often regular plates which accompany anchors. (Plate LXXXI, figs. 1*a*, 2.)

anchors, anchor-shaped deposits of *Synapta* and allied genera. (Plate LXXX, fig. 1*b*.)

buttons, buckle-shaped deposits often accompanying tables. (Plate LXVII, figs. 2*c*, *d*, *e*.)

calcareous ring, a ring, made up of plates of lime, around the œsophagus; generally ten pieces, five of which serve as points of attachment for radial muscles (q. v.) and are called *radial pieces* or *radialia*, while the alternate five are termed *interradial pieces* or *interradialia*. (Plate LXXXII, fig. 1.)

Cuvierian organs, long, slender, often whitish tubes attached to proximal portion of respiratory tree in a tuft or bunch. When ejected violently they serve as organs of defense, being very viscid and extraordinarily extensible; present especially in species of *Holothuria* and *Actinopyga*.

digitate, said of tentacles when the branches are few and arisē from tip so as to resemble miniature fingers. (Plate LXXXI, fig. 5.)

disk, perforated plate forming the base of a table. (Plate LXVII, fig. 2*b*.)

gonad, the ovary or testis, as the case may be.

interambulacra, interradii, or the five longitudinal areas between the radii.

interradial pieces, see calcareous ring. (Plate LXVIII, fig. 4*a*, *i r*.)

madreporic canal, the calcareous canal connecting the ring canal of water vascular system with body cavity, or with exterior in many Elpidiidæ. Often numerous in a single individual, frequently single. (Plate LXXX, fig. 1, *m*.)

mesentery, especially the dorsal mesentery, the sheet of transparent tissue joining the œsophagus and intestine to body wall. The anterior portion of alimentary canal is slung by the dorsal mesentery to the middorsal (interradial) line of body wall. (Plate LXXX, fig. 1, *me.*)

miliary granules, simplest form of calcareous deposits, namely, more or less irregular grains.

papillæ, ambulacral appendages in which the sucking disk is absent and the terminal plate absent or rudimentary.

pedicels, tube feet, or locomotor organs, having a terminal sucking disk.

peltate, said of tentacles having a circular, flattish, or convex crown.

pinnate, of tentacles having the branches occurring regularly along the sides in two opposite series and without subdivisions. (Plate LXVI.)

plates, thin, flat, wide, usually perforated deposits. (Plate LXXIX, fig. 1, *b.*)

Polian vesicle, cul-de-sac, or reservoir, connected with ring canal of water vascular system. (Plate LXXX, fig. 1, *p. v.*)

posterior prolongations of calcareous ring. (Plate LXXIX, figs. 2, 3.)

radial muscles, the five, usually double, bands of muscle running from end to end of the animal along the five radii.

radial pieces, see calcareous ring. (Plate LXXXII, fig. 1, *r.*)

respiratory trees, when present, a pair of long, much-branched outgrowths of wall of cloaca, lying in body cavity, usually unequal in length. The left is frequently associated with the *rete mirabile*. (Plate LXXIV, fig. 1, *r.*)

rete mirabile, complex plexus of blood vessels between the dorsal vessel (marginal vessel of the *rete mirabile*) and the lacunar network of the alimentary canal. Some of the numerous small retia mirabilia form webs around the terminal ramifications of the left respiratory tree.

retractor muscles, anterior free portion of radial muscle attached to end of radial piece of calcareous ring and serving to retract tentacles and anterior portion of body into body cavity for protection.

rods, rod-shaped deposits. (Plate LXXV, figs. 1–5.)

rosettes, calcareous deposits in the form of rods more or less irregularly and profusely branched. (Plate LXVII, figs. 1*c*, 4*a*; Plate LXXX, fig. 1*c*.)

spire, upright portion of a table. (Plate LXVII, fig. 2*a*; Plate LXXII, figs. 1*a–e*.)

supporting rods, calcareous rods in walls of tentacles, papillæ, and pedicels. (Plate LXVIII, fig. 4; Plate LXIX, fig. 1*g*.)

table, a perforated plate having a projection, made up of several rods more or less joined together, rising perpendicularly from the middle. (Plate LXVII, fig. 2*a*.)

tentacle ampulla, vesicles of the ambulacral system connected with the tentacles and lying in the body cavity, around the calcareous ring.

tentacles, modified ambulacral appendages surrounding the mouth, often much branched. (Plate LXVI, *t.*)

wheels, wheel-shaped deposits. (Plate LXXVIII, fig. 1.)

EXPLANATION OF PLATES.

(All figures were drawn by the writer.)

PLATE LXVI.

Fig. 1. *Ophcodesoma spectabilis.* From a colored sketch of a medium-sized living animal. About four-fifths natural size. The present illustration does not truly reproduce the shades. The excrescences, and often a narrow transverse band between them, are much darker than the interspaces; the former are brown, the latter orange, except posteriorly on the ventral surface, which is grayish barred with darker gray, often almost black.

PLATE LXVII.

Fig. 1. *Actinopyga mauritiana.* Rods and grains from ventral perisome, × 200. 1*a–d.* Rods from dorsal perisome, × 400.

2. *Actinopyga parvula.* Table viewed from above, showing crown and disk. 2*a.* Slightly larger table from side. 2*b.* Disk of table. 2*c–e.* Buttons. 2*f.* Plate and rod from dorsal papilla, × 200. 2*g.* Calcareous ring, mediodorsal piece without anterior tooth, × 3.

3. *Actinopyga obesa.* Rods from perisome, × 400.

4. *Holothuria paradoxa.* Several rods from dorsal perisome, × 200. 4*a.* Same, × 400. 4*b.* Rods from dorsal pedicels, × 200. (See also Plate LXIX, fig. 5.)

5. Same. Various forms of rods from ventral perisome, × 200.

PLATE LXVIII.

Fig. 1. *Holothuria cinerascens.* Crown of table. 1*a.* Smaller table from side. 1*b.* Larger table. 1*c–1e.* Various forms of disks of tables. 1*f.* Rough rods from general perisome. All × 200.

2. *Holothuria pervicax.* Two views of table. 2*a.* Tables with rudimentary spire. 2*b.* Various forms of rods from general perisome. 2*c.* Larger rod intermediate between supporting rods and the small button-like rods of general perisome, × 200.

3. *Holothuria fuscorubra.* Reduced disk of table. 3*a–c.* Various forms of tables. 3*d.* Various forms of buttons. 3*e.* Button from near tip of pedicel, × 200.

4. *Holothuria hawaiiensis.* Supporting rods of pedicels and papillæ, × 200. 4*a.* Two radial and 1 interradial (*ir*) piece of calcareous ring, × 4. 4*b.* Large table from above, showing disk and crown. 4*c.* One type of small table. 4*d.* A large table from side. 4*e.* Disk of smaller table. 4*f.* Another type of small table. 4*g.* Various forms of buttons, some of them incomplete. × 200.

5. *Holothuria arenicola.* Table from above, the crown, and side. 5*a–5b.* Two forms of buttons. 5*c.* Supporting rod, dorsal pedicels, × 200.

PLATE LXIX.

Fig. 1. *Holothuria pardalis.* 1, 1*a–d.* Various forms of tables; 1*b* crown; 1, 1*a* disk from beneath. 1*e.* Supporting rod from pedicel. 1*f.* Various forms of buttons. 1*g.* Supporting rod from dorsal pedicel, × 200.

2. *Holothuria anulifera.* Disk of table and crown, from above. 2*a.* Table from side. 2*b.* Table from wall of papilla, viewed from one side; this type rather uncommon. 2*c.* A rare form of complete button. 2*d.* Usual form of incomplete knobbed buttons and knobbed rods, × 200.

Fig. 3. *Holothuria fusco-olivacea.* Disk of commonest form of table. 3*a*. Very rare form of large table (tip missing). 3*b*. Small table. 3*c*, 3*d*. Crowns of tables. 3*e*. One of the commoner tables from side. 3*f*. Various forms of buttons; x and x^1 are covered with small knobs, but these have been omitted to show more clearly the perforations, × 200. See also Plate LXX, fig. 3.

4. *Holothuria impatiens.* Disk of a regular table. 4*a*. Crown, from above, and characteristic table from side. 4*b*. Button. 4*c*. Supporting rod from papilla. 4*d*. Less regular table disk, × 200.

5. *Holothuria paradoxa.* A supporting rod from dorsal pedicel, × 200.

Plate LXX.

Fig. 1. *Stichopus tropicalis.* Large table, side view. 1*a*. Disk of large table. 1*b* Crown of smaller table, dorsal perisome. 1*c*. Smaller table, dorsal perisome; disk, side view, and crown. 1*d*. Rods from dorsal perisome. 1*e*. Disk of a table intermediate between the large and small tables. 1*f*. Side view of same. 1*g*. C-shaped rods, × 200. 1*h*. Supporting rod, ventral pedicel, × 140. 1*i*. Spire of ventral table.

2. *Holothuria atra.* Crown and side view of characteristic table. 2*a*. Disk of same. 2*b*. One of the small rods from general perisome, × 200. 2*c*. One of the rods forming a perforated plate, × 665.

3. *Holothuria fusco-olivacea.* Supporting rod of pedicel, × 200.

4. *Mesothuria carnosa.* Disk of one of the larger tables. 4*a*. Side view of characteristic table; only two spire rods shown. 4*b*. Table seen from above, showing disk and crown of spire. 4*c*. Two views of one of the smaller tables. 4*d*. Smaller table with sample crown, viewed from above. 4*e*. Reduced table from wall of pedicel. 4*f*. Medium-sized rod from oral disk. All × 200.

Plate LXXI.

Fig. 1. *Mesothuria murrayi.* Large table viewed from above, showing disk and crown. 1*a* and 1*b*. Two characteristic tables showing variation in spire. 1*c*. Disk of a small table of general perisome. 1*d*–1*g*. Various forms of tables from pedicels. 1*h*. Very characteristic simple disk tables of general perisome. Here the secondary peripheral perforations are lacking. Compare with 1 and 1*c*, × 200.

2. *Mesothuria parva.* Characteristic table, side and top view. 2*a*–2*c*. Various forms of crowns of tables, × 200.

3. *Pseudostichopus propinquus.* Deposits from wall of respiratory tree. 3*a*–*b*. Same, × 400.

4. *Mesothuria carnosa* (young?). Side view of table of a small Mesothuria referred with doubt to *carnosa*. 4*a*. Disk and crown of same, × 200.

Plate LXXII.

Fig. 1. *Bathyplotes patagiatus.* Disks of tables from ventral perisome. 1*a*. Table from dorsal perisome. 1*b*. Disk of table from ventral perisome. 1*c*. Disk of large table from base of the large dorsal papillæ. 1*d*. Side view of table from ventral perisome. 1*e*. Side view of large table from base of dorsal papillæ. 1*f*. Table from dorsal papilla proper. 1*g*. Two arms of a disk of table from perisome at base of a large dorsal papilla. 1*h*. C-shaped rods in subcutaneous layer of body wall. $1h^1$. From wall of gonad (lower figure). 1*i*. Supporting rods from dorsal papillæ. The lower figure shows a tip viewed from a flat side, × 175. 1*j*. Calcareous ring, radial piece directly over figure, × 4. 1*k*. Supporting rod from dorsal papilla, × 175.

Fig. 2. *Pseudostichopus propinquus.* Calcareous ring, one of the dorsal radial and interradial pieces. 2*a*. Ventral radial and interradial pieces.

PLATE LXXIII.

Fig. 1. *Orphnurgus insignis.* Dorsal view of large specimen. Two-thirds natural size.
2. *Anapta inermis.* Ventral view, showing general form. Two-thirds natural size.
3. *Pseudostichopus propinquus.* Ventral view, × 1.

PLATE LXXIV.

Fig. 1. *Pseudostichopus propinquus.* Dissected from above to show alimentary canal, anal aperture (*a*), ring canal (*c*), cloacal cavity (*cl*), gonad (*g*), longitudinal muscle bands (*lm*), dorsal mesentery (*m*), madreporic canal (*mc*), Polian vesicle (*p*), respiratory trees (*r*). × 1⅓.
2. *Scotodeima vitreum.* Ventral view, showing the large semirigid papillæ and two rows of pedicels on either ventrolateral radius. *a*, *b*, *c*, dorsal papillæ. × 1⅓. 2*a*. Calcareous ring, the radial portion with perforation. × 6.

PLATE LXXV.

Fig. 1. *Scotodeima vitreum.* Rods from large lateral or flank papillæ. 1. From middle portion. 1*a*. From distal portion. 1*b*. Irregular rod from basal half. 1*c*, 1*d*. Distal portion. 1*c*. From tip. 1*e*. Characteristic large rod from basal portion. Note that 1*e* is the other half of 1*é*. × 66.
2. Same. Rods from dorsal perisome. 2*a*–*c*. Other rods from dorsal perisome. × 66. See also Plate XI, fig. 1*a*.
3. Same. Rods from wall of gonad.
4. Same. Rods from ventrolateral pedicels, the larger from near base, the smaller from tip. × 66.
5. *Lætmogone biserialis.* Rod from ventral perisome. 5*a*. Another rod. × 175.

PLATE LXXVI.

Fig. 1. *Scotodeima vitreum.* Characteristic rod from ventral perisome. 1*a*, 1*b*, 1*c*. Rods from ventral perisome. 1*c*. Showing a slightly more complicated form than 1. × 66.
2. Same. Large rod from dorsal perisome. × 66.
3. *Pseudostichopus propinquus.* 3*a*–3*b*. Rods from wall of gonad. × 400.

PLATE LXXVII.

Fig. 1. *Orphnurgus insignis.* 1, 1*a*–*e*. Various forms of rods from dorsal perisome. × 66.
2. Same. 2, 2*a*–*e*. Rods of ventral perisome, anterior two-thirds of body. × 66.
3. Same. Large ellipsoid from ventral perisome in posterior third of body. 3*a*. Rod intermediate between ellipsoid and fig. 2, from posterior region, ventral perisome. 3*c*. Smaller smooth ellipsoid from same region. 3*b*, 3*b*^{1}, 3*d*, 3*e*. Rods from pedicels. (Fig. 1*c* is the commoner type in the papillæ.) × 200.

PLATE LXXVIII.

Fig. 1. *Lætmogone biserialis.* Wheel from dorsal perisome, viewed from convex side. 1*a*. Edgewise view of same. 1*b*. Wheels from ventral perisome. That on left from convex side, × 175. That on right from concave side, × 350. 1*c*. Small wheel from dorsal papilla, × 175. 1*d*. Rod from ventral perisome, × 175. 1*e*. Rod from pedicel, × 175.

Fig. 2. *Pannychia pallida*. Large wheels from general perisome, viewed from concave side. 2*a*. Another from convex side. 2*b*. Small wheels of general perisome and pedicels. 2*c*. Edgewise view of large wheel. 2*d*. Modified wheel-like plate at end of papillæ. 2*e*. Wheel-like plate from oral disk. 2*f*. Rod from end of tentacle, × 175. 2*g*. Calcareous ring, radial piece perforated, × 4. 2*h*. Rods from oral disk.

PLATE LXXIX.

Fig. 1. *Psolus macrolepis*. Dorsal surface, × 2. 1*a*. Same, ventral, × 2. 1*b*–1*c*. Plates from ventral perisome, × 200. 1*d*. Calcareous ring, three pieces, radial in center, × 6. 1*e*. Rod from tentacle, × 200. 1*f*. Perforated plate from perisome between base of tentacles and oral valves.

2. *Thyonidium hawaiiense*. Three radial (*r*) and two interradial (*ir*) pieces of calcareous ring, × 4⅔. 2*a*. Disk of table from general perisome. 2*b*. Side view of same. 2*c*. Spire of table with four prongs. 2*d*. Disk of table from perisome at base of tentacles. 2*e*. Rod from oral plate, × 200.

3. *Thyonidium alexandri*. Calcareous ring, two radial and three interradial pieces, × 4⅔.

PLATE LXXX.

Fig. 1. *Opheodesoma spectabilis*. Cartilaginous ring, Polian vesicles, etc., viewed from side. *cr.*, cartilaginous ring. *cu.*, ciliated urns. *g.*, gonad. *gd.*, gonoduct. *i.*, intestine. *m.*, madreporic canals. *me.*, dorsal mesentery. *pv.*, Polian vesicles (very numerous), × 2⅔. 1*a*. Calcareous ring (radial pieces, *r*, with perforations), × 3⅓. 1*b*. Anchor, slightly less than × 200. 1*c*. Miliary rosettes, upper, × 330; lower, less than × 200, or same magnification as anchor. 1*d*. Rods from oral disk, × less than 200.

2. *Synaptula kefersteinii*. Miliary grains, × 666.

3. *Thyonidium alexandri*. Characteristic table, side view. 3*a*. One of the regular tables viewed from above. 3*b*. A larger table with more irregular disk, seen from above. 3*c*, 3*d*. Tables from pedicels. 3*e*. Plate from perisome at base of tentacles, × 200.

PLATE LXXXI.

Fig. 1. *Protankyra albatrossi*. An anchor and miliary grains. 1*a*. Anchor plate, × 200.

2. *Opheodesoma spectabilis*. Anchor plate, × somewhat less than 200.

3. *Euapta godeffroyi*. Anchor. 3*a*. Miliary rosettes. 3*b*. Rod from tentacle. 3*c*. Anchor plate, × less than 200.

4. *Chiridota uniserialis*. A tentacle, × 13.

5. *Chiridota hawaiiensis*. A tentacle, × 13.

PLATE LXXXII.

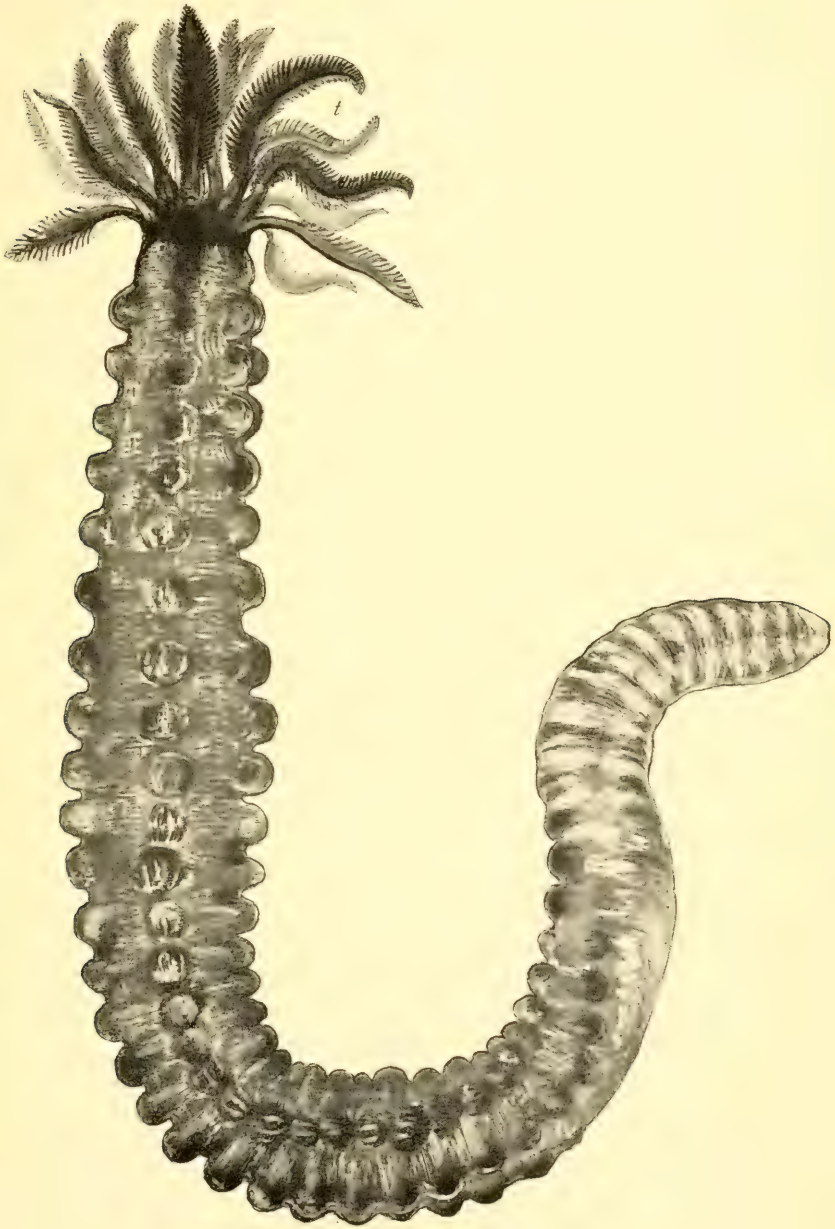
Fig. 1. *Anapta inermis*. Calcareous ring, ring canal, etc.; *al.*, alimentary canal; *gon.*, gonad.; *m.*, madreporic canal; *pv.*, Polian vesicle; *r.*, radial pieces of calcareous ring, × 2.

2. *Tæniogyrus* sp. One of the sigmoid deposits, × 200.

3. *Chiridota hawaiiensis*. A wheel. 3*a*. Grains from subcutaneous layer along radii, × 200. 3*b*. Rods from tentacles, × 400. 3*c*. Same. 3*d*. Calcareous ring, × 13. 3*e*. Rods from general perisome, × 200. 2*e'*. Same, × 400. (Fig. to right.)

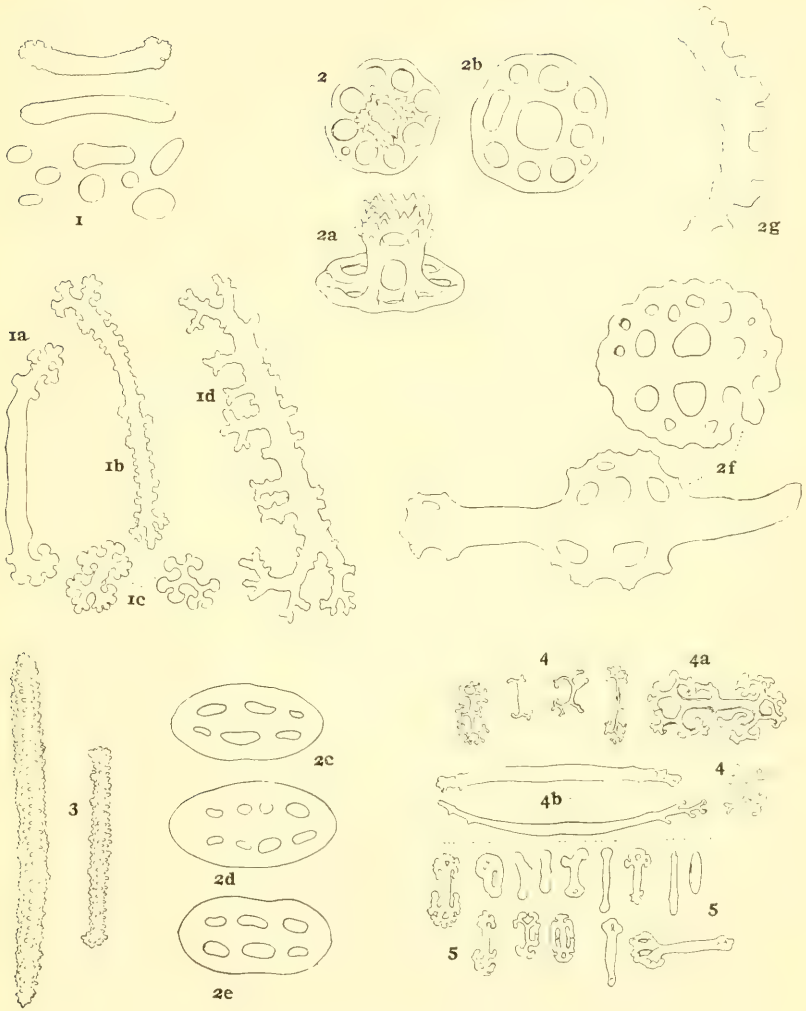
4. *Protankyra albatrossi*. End of anchor plate, showing incipient handle, × 200. 4*a*. Calcareous ring, × 6⅔. 4*b*. Deposits from tentacles. 4*c*. From oral disk, × 200.

5. *Chiridota uniserialis*. Wheel. 5*a*. Rods from general perisome, × 400. 5*b*. From subcutaneous layer, along radii, × 200. 5*c*. Calcareous ring, × 13.



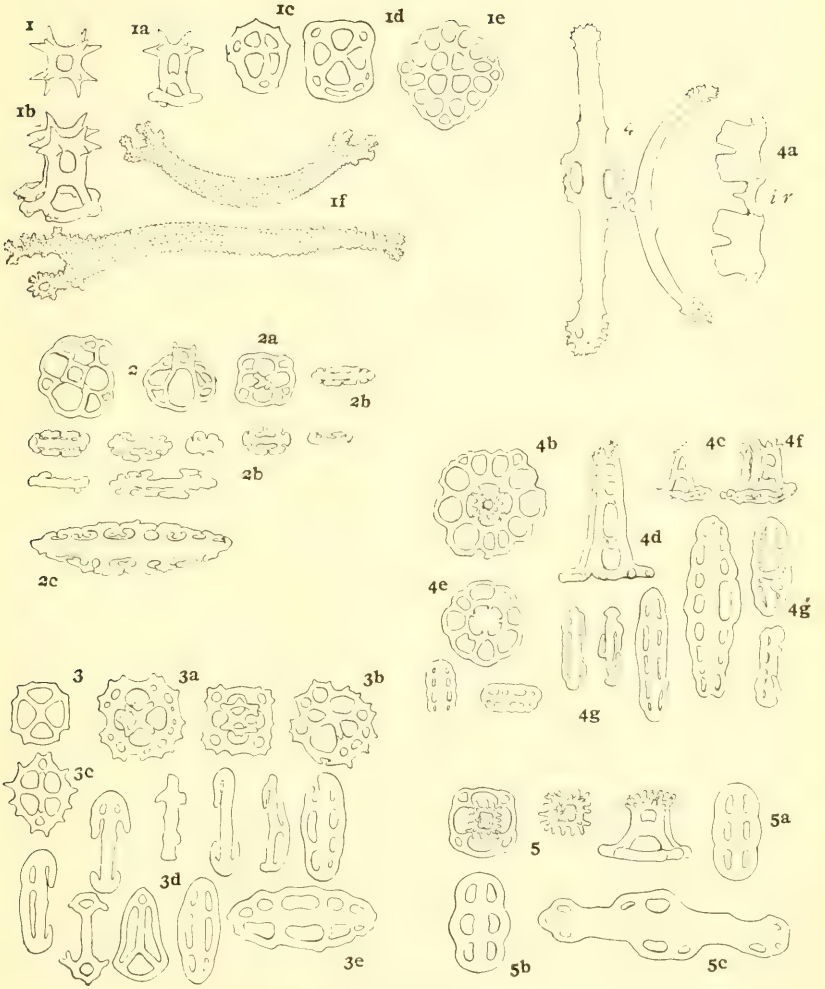
OPHEODESOMA SPECTABILIS.

FOR EXPLANATION OF PLATE SEE PAGE 741.



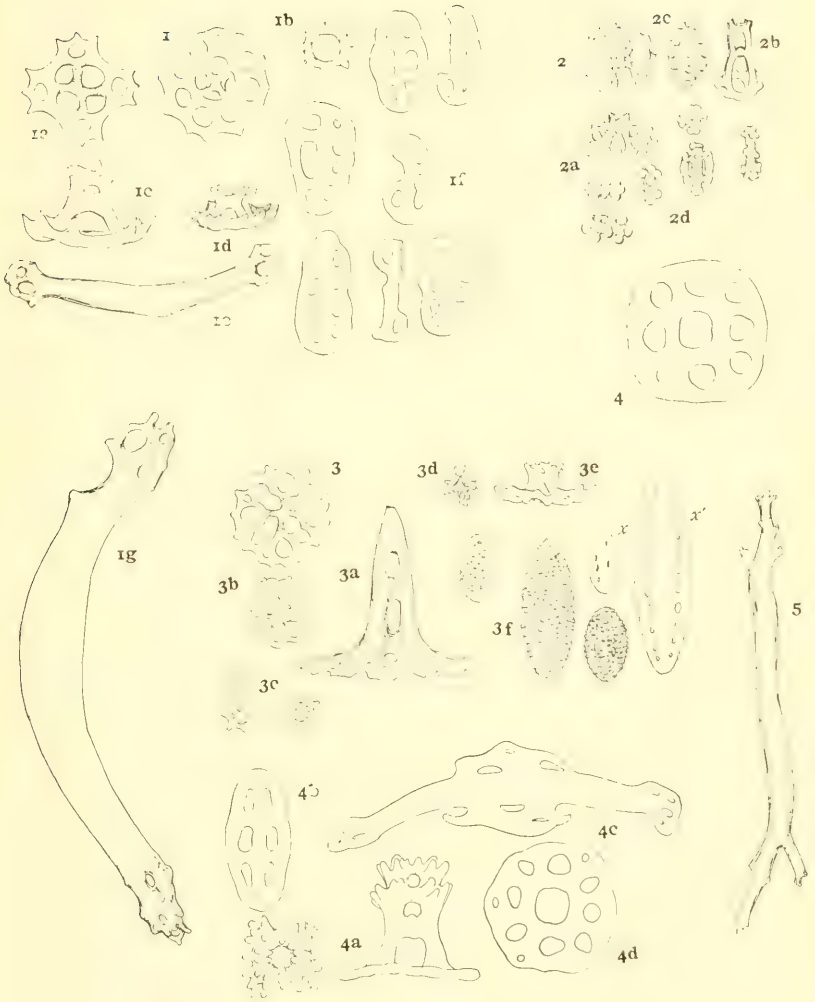
ACTINOPYGA, HOLOTHURIA.

FOR EXPLANATION OF PLATE SEE PAGE 741.



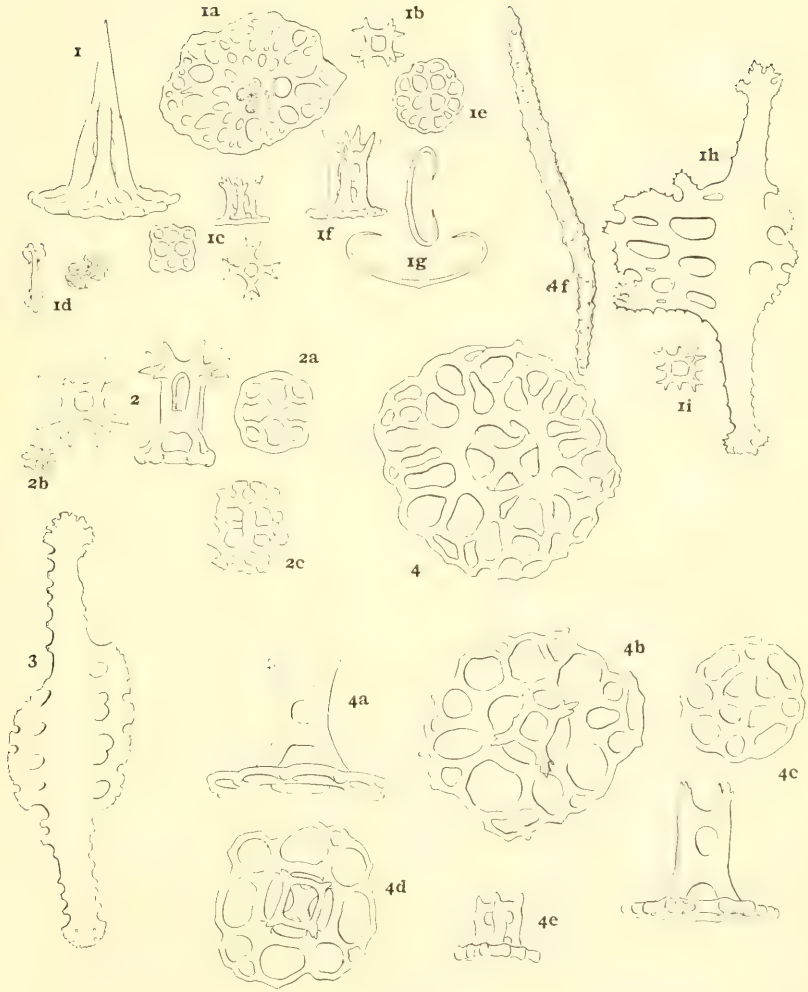
HOLOTHURIA.

FOR EXPLANATION OF PLATE SEE PAGE 741.



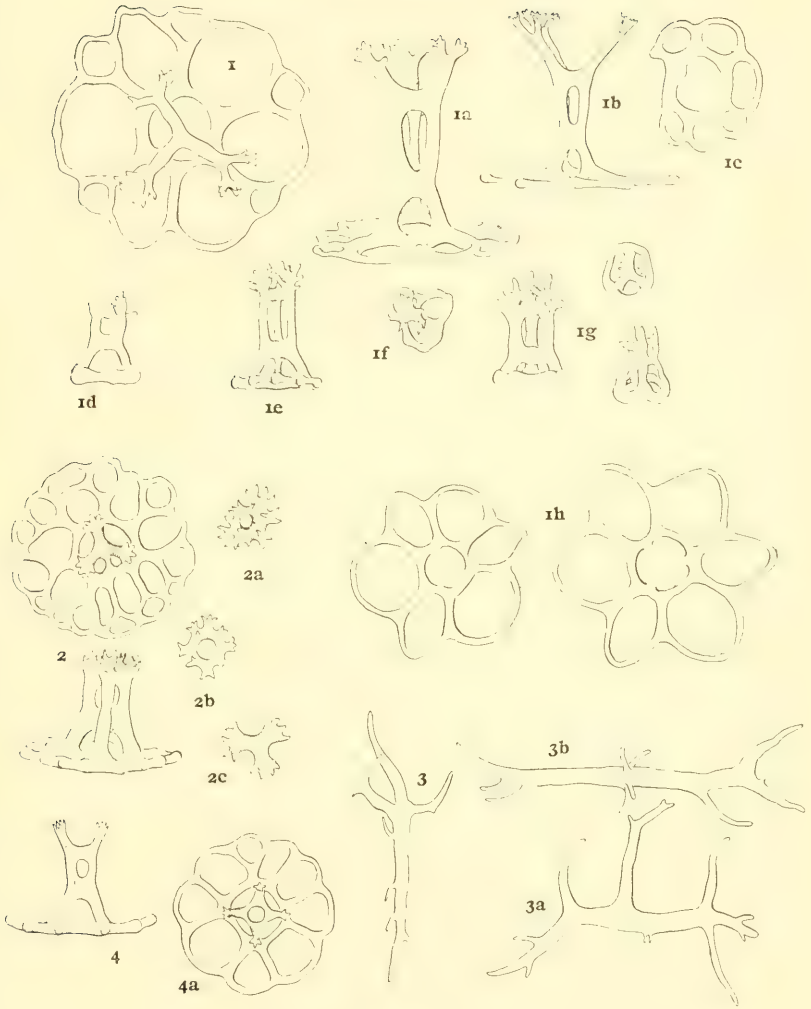
HOLOTHURIA.

FOR EXPLANATION OF PLATE SEE PAGE 742.



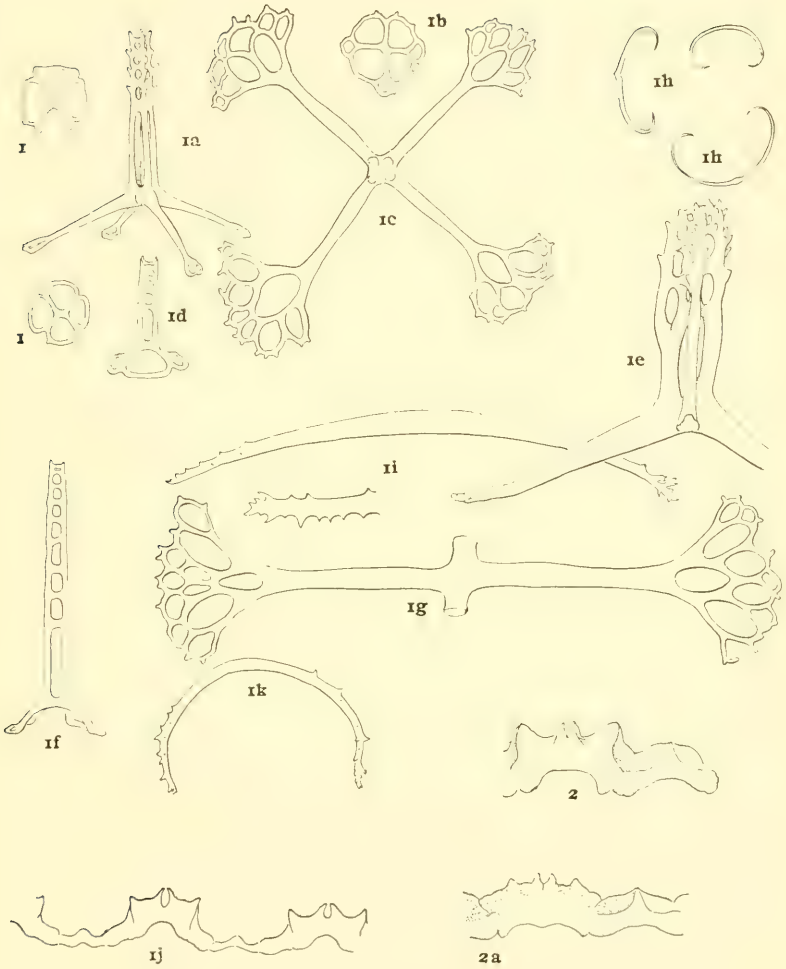
HAWAIIAN HOLOTHURIIDÆ.

FOR EXPLANATION OF PLATE SEE PAGE 742.



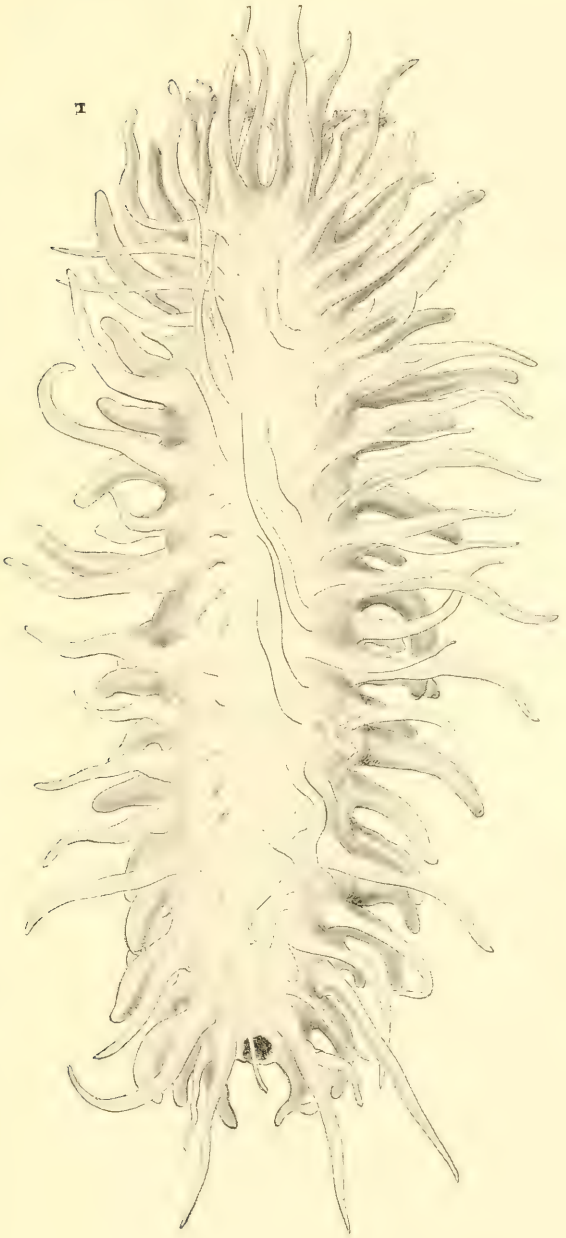
MESOTHURIA, PSEUDOSTICHOPUS.

FOR EXPLANATION OF PLATE SEE PAGE 742.



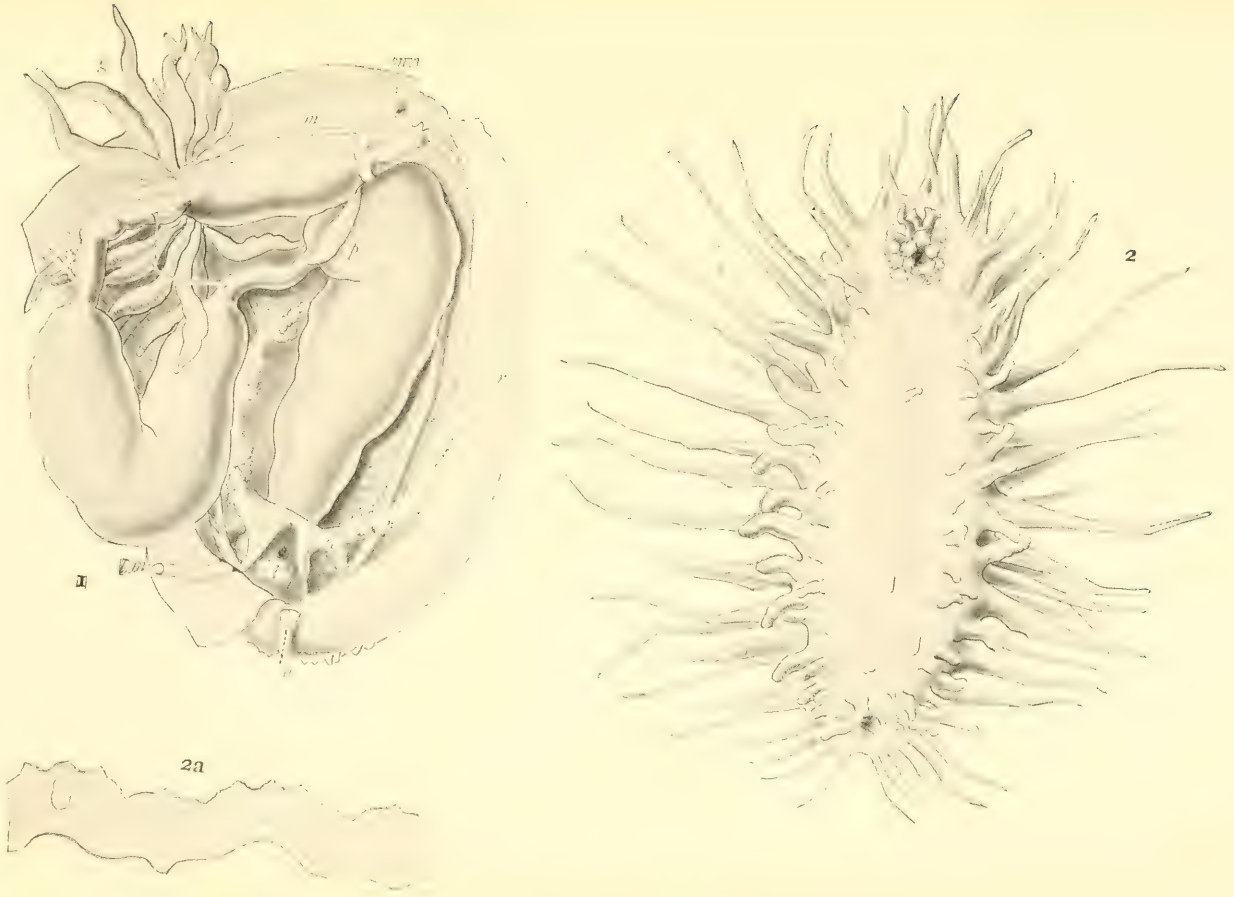
BATHYPLOTES, PSEUDOSTICHOPUS.

FOR EXPLANATION OF PLATE SEE PAGES 742 AND 743.



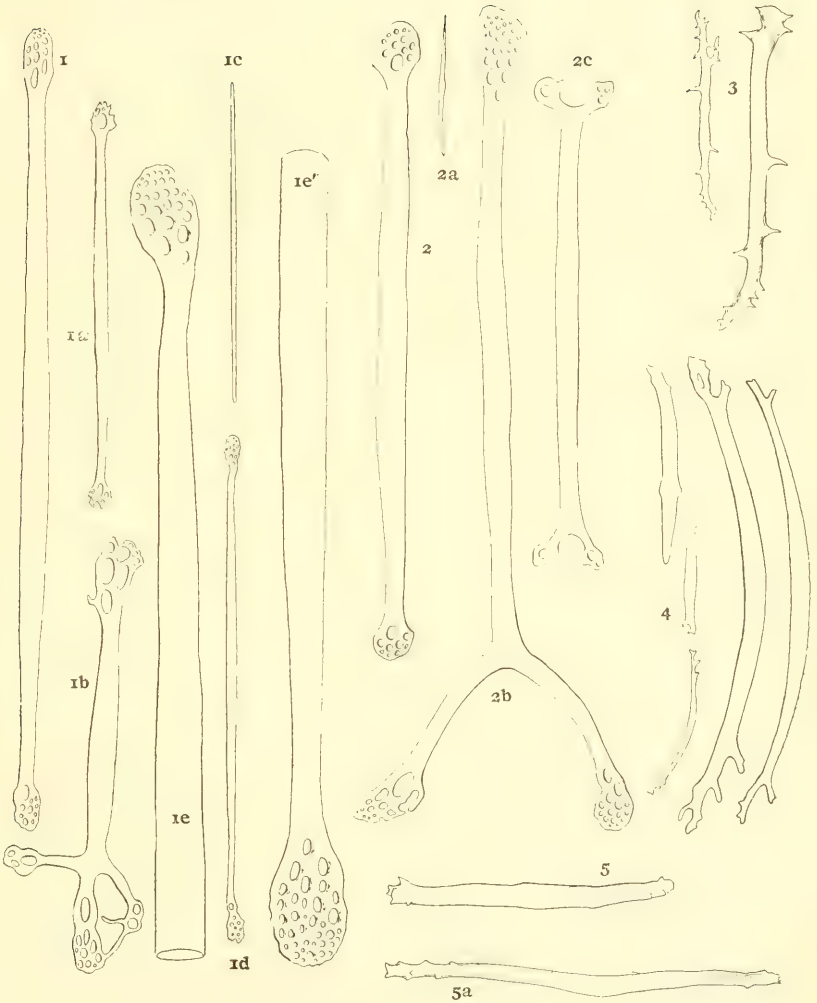
HAWAIIAN HOLOTHURIANS.

FOR EXPLANATION OF PLATE SEE PAGE 743.



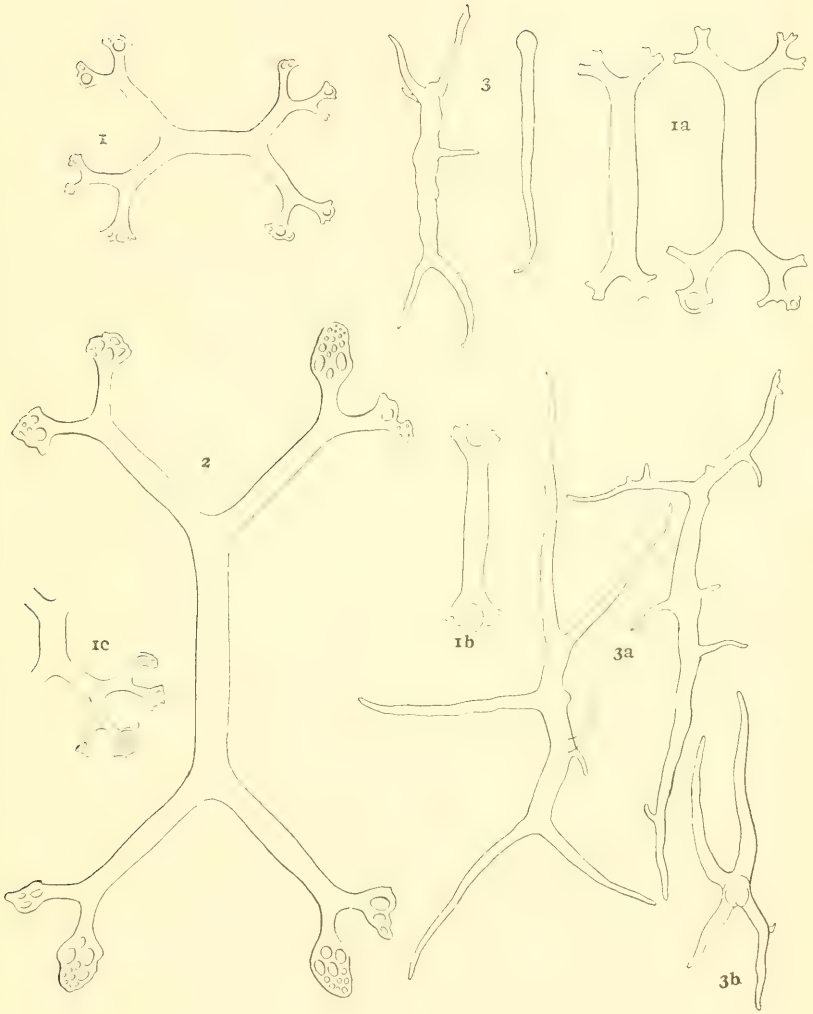
PSEUDOSTICHOPUS, SCOTODEIMA.

FOR EXPLANATION OF PLATE SEE PAGE 743.



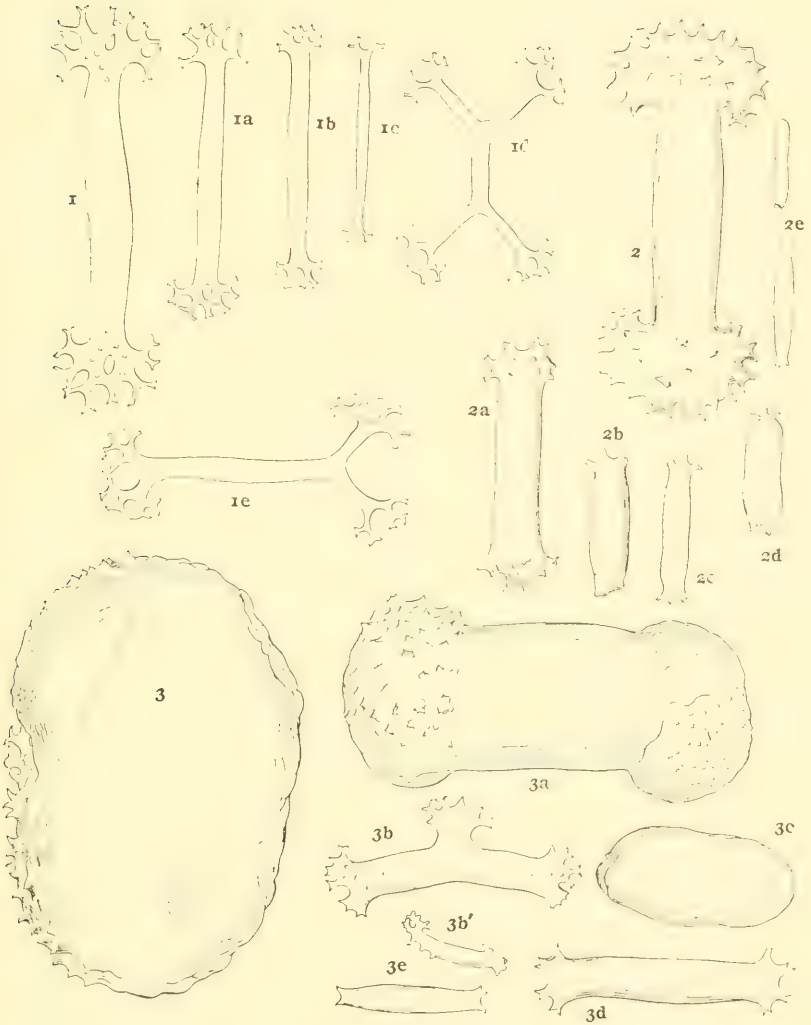
SCOTODEIMA, LÆTMOGONE.

FOR EXPLANATION OF PLATE SEE PAGE 743.



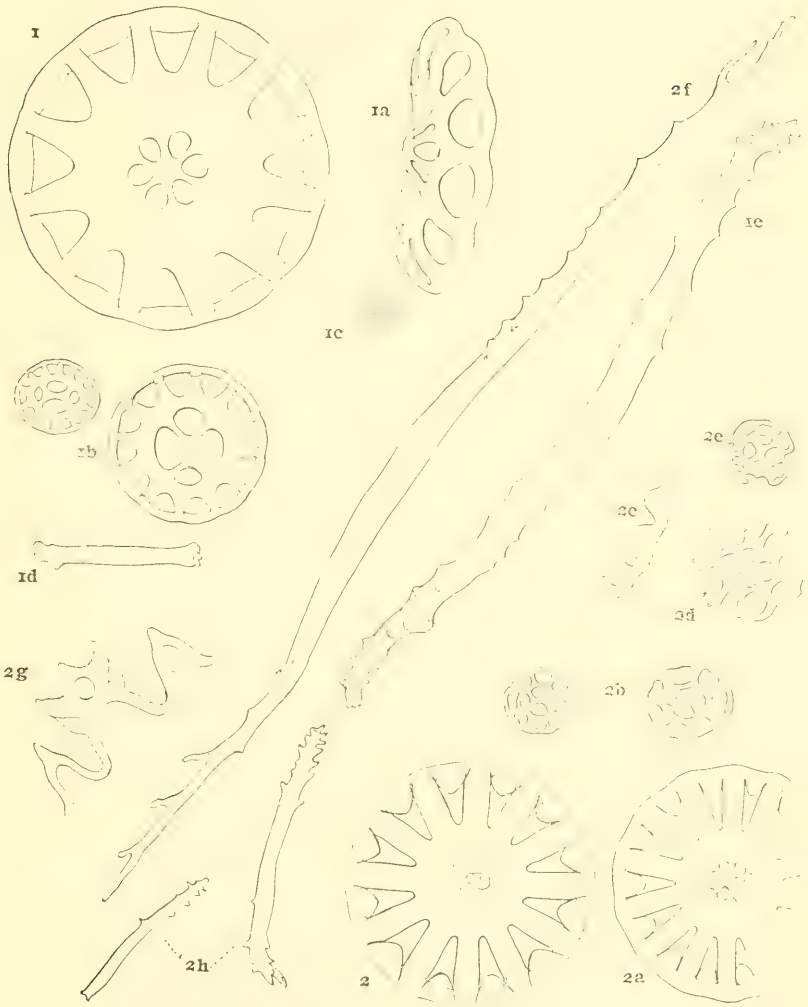
SCOTODEIMA, PSEUDOSTICHOPUS.

FOR EXPLANATION OF PLATE SEE PAGE 743.



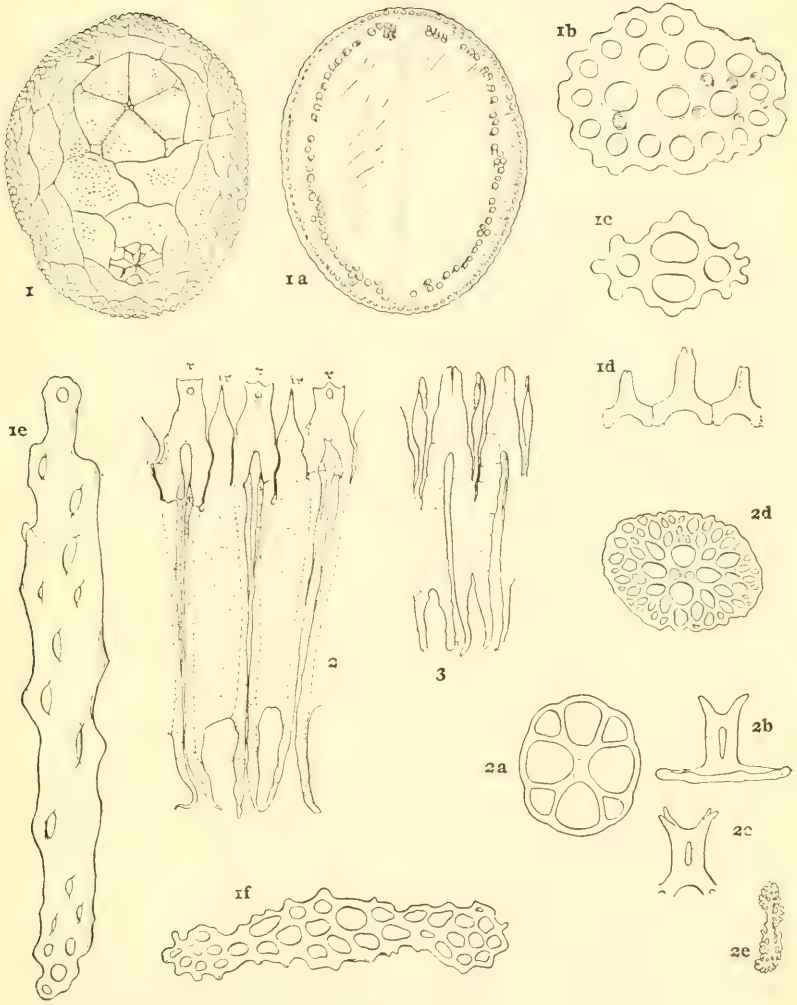
ORPHNURGUS INSIGNIS.

FOR EXPLANATION OF PLATE SEE PAGE 743.



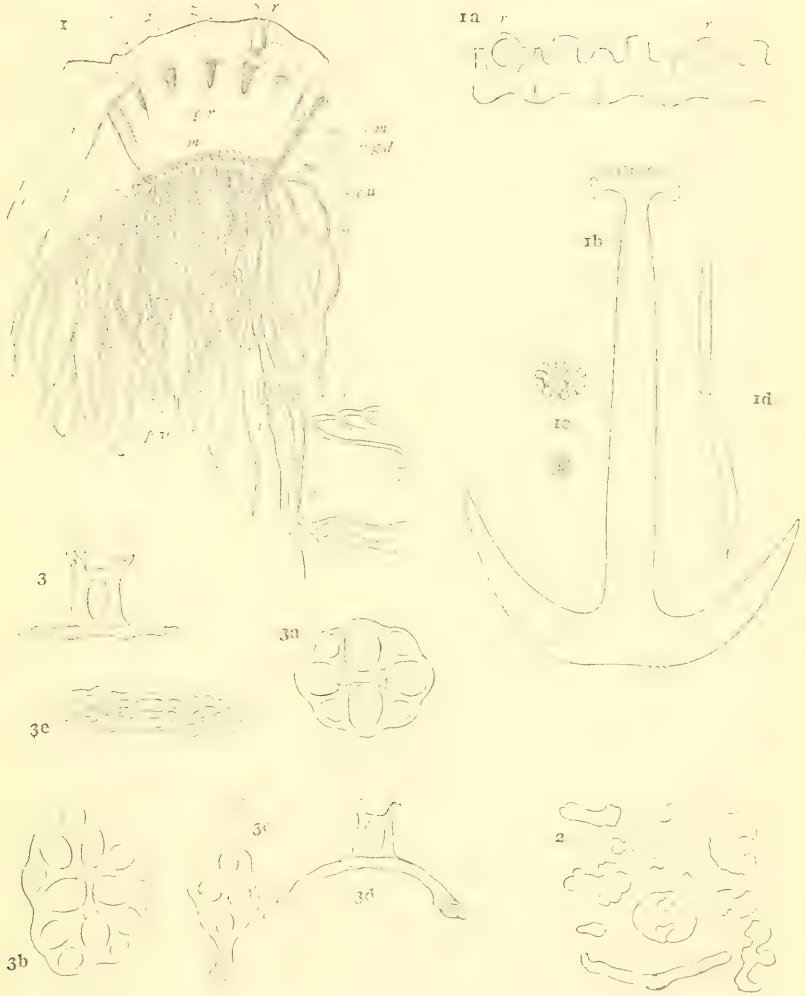
HAWAIIAN ELPIDIIDÆ.

FOR EXPLANATION OF PLATE SEE PAGES 743 AND 744.



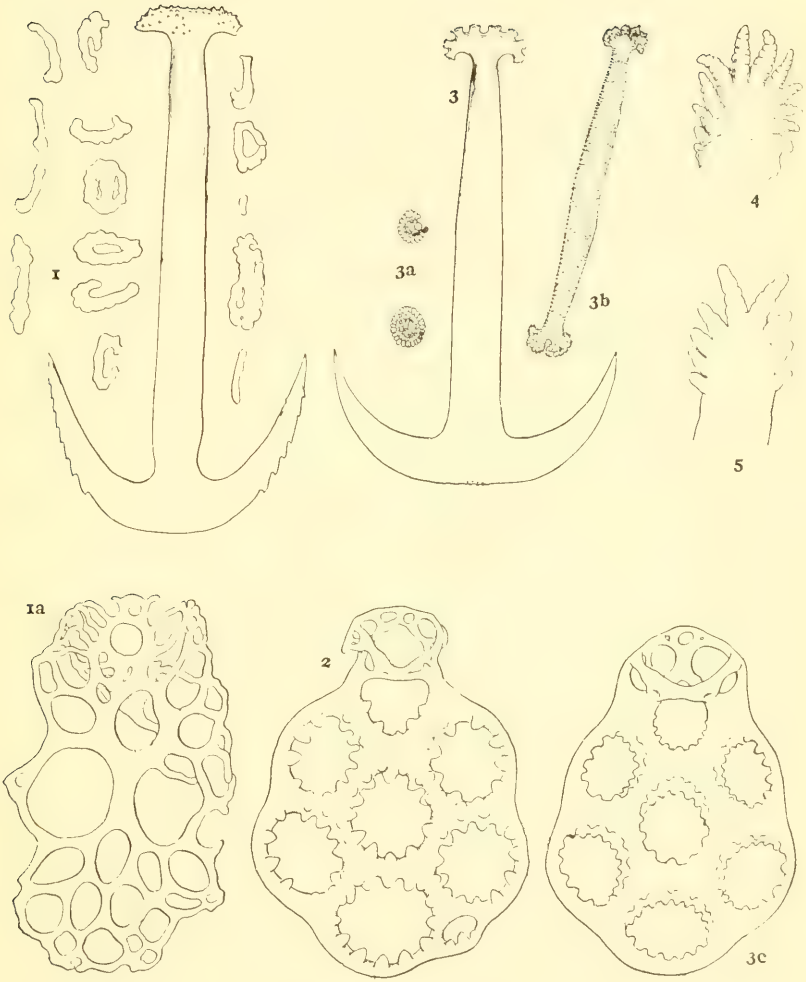
HAWAIIAN CUCUMARIIDÆ.

FOR EXPLANATION OF PLATE SEE PAGE 744.



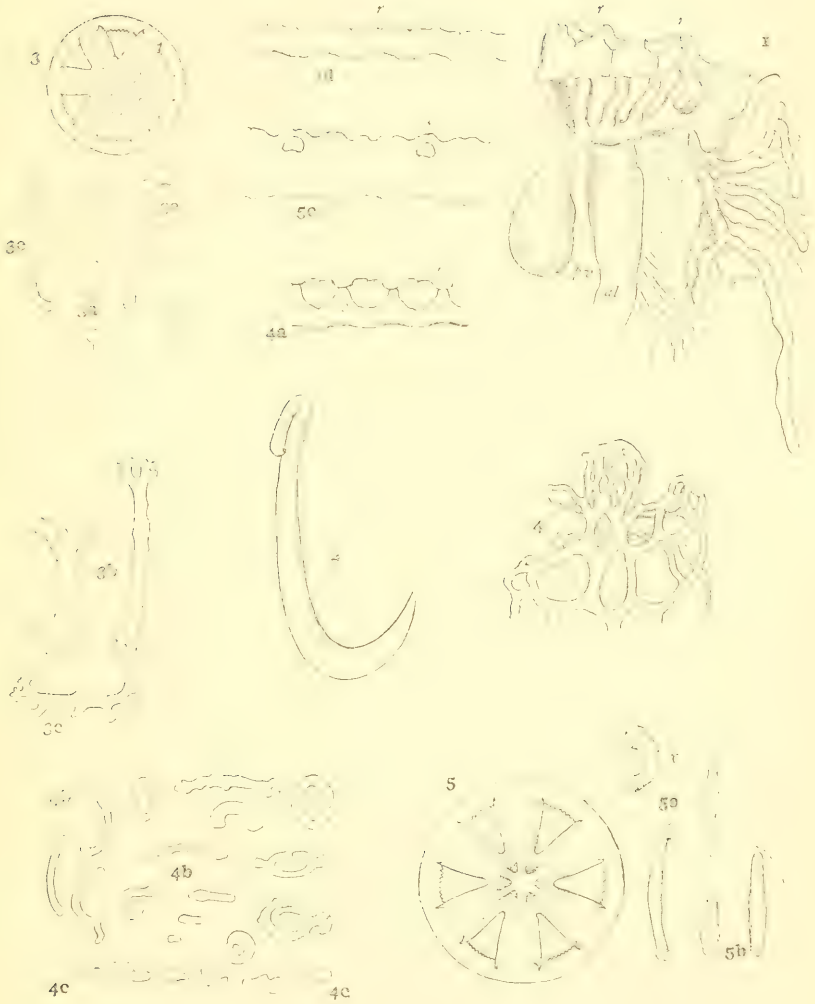
OPHEODESOMA, SYNAPTULA, THYONIDIUM.

FOR EXPLANATION OF PLATE SEE PAGE 744.



HAWAIIAN SYNAPTIDÆ.

FOR EXPLANATION OF PLATE SEE PAGE 744.



HAWAIIAN SYNAPTIDÆ.

FOR EXPLANATION OF PLATE SEE PAGE 774.

INDEX.